

SCIENCE

FOR THE SECOND YEAR OF MIDDLE SCHOOL

2
prep



MS

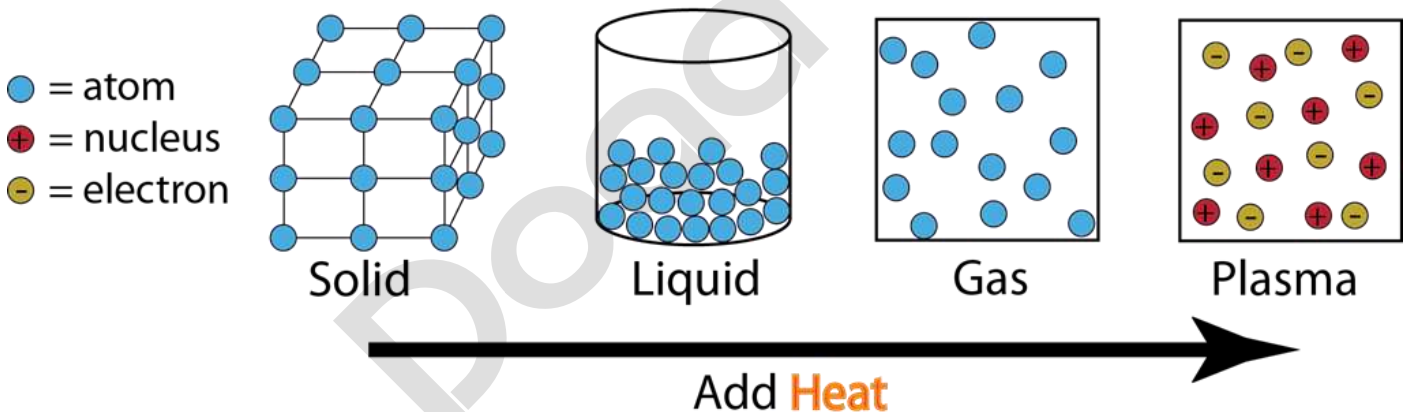
DOAA YASSER

Unit 1: Matter & Energy

L1: States of Matter

INTRODUCTION

- Matter exists in three basic states: solid, liquid, and gas.
- There is a fourth state called plasma.
- The differences between the states lie in: shape, volume, particle motion, and cohesive force.



States of Matter & Their Properties

Scientists attempt to observe common patterns and properties among substances to facilitate their study and classification, such as:

- ❖ Classifying chemical elements.
- ❖ Classifying living organisms.
- ❖ Classifying substances according to their common physical states: solid, liquid, or gas.



Matter: Anything that has mass and occupies space.

Mass: A constant quantity that doesn't change with location.

Note: The properties of matter vary depending on its physical state, as we'll explain in the following activities.

First: shape and flowability

Which of the following states of matter changes shape when transferred from one container to another?

liquid and gas.

Which can flow or flow?

liquid and gas.

Which substance has a fixed shape?

solid.

Important Conclusions

Solid: (such as iron and wood) has a fixed shape and volume.

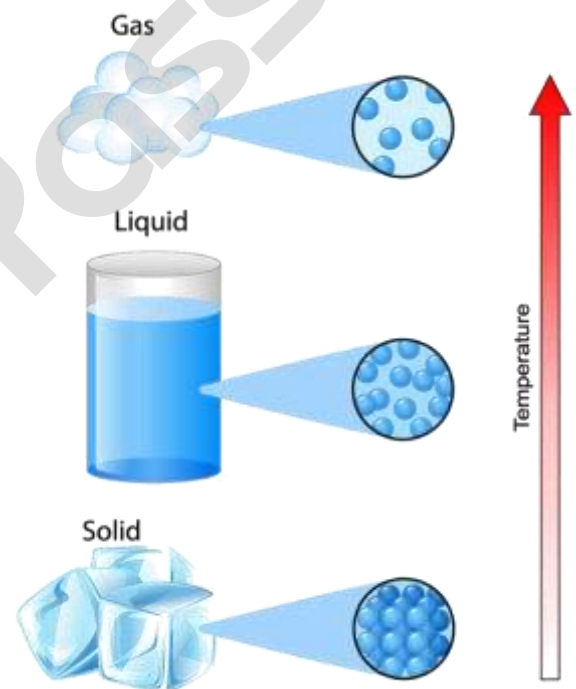
Liquid: (such as water and oil) can be poured and takes the shape of the container, but its volume is fixed.

The flow of liquids varies according to their viscosity.

Gas: (such as air) takes the shape of the container, but its volume changes depending on pressure.

Liquids and gases are classified into a single group known as fluids.

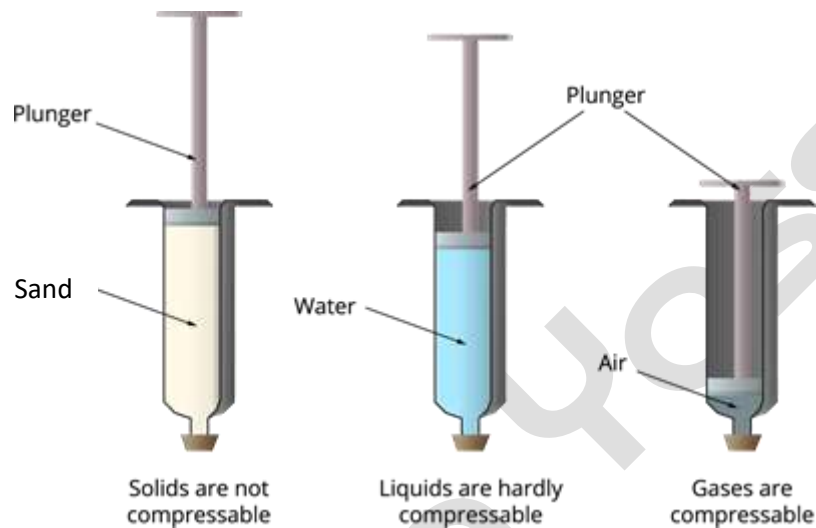
Fluids: A name given to both liquids and gases because of their ability to flow.



Second: Size and compressibility

Activity: Demonstrating Compressibility:

Equipment: Identical syringes, airtight stoppers, equal amounts of air, water, and fine sand.



Steps:

- Closed the opening of each syringe with the stopper.
- Put the three substances into each syringe.
- Gradually depress the plunger.
- Note the change in volume of the substance inside each syringe.

Observations (Conclusion)

- Air: Can be easily compressed (compressible gas).
- Water: Incompressible (incompressible liquid).
- Sand: Incompressible (solid and incompressible).

Conclusion:

Compressibility: Distinguishes gases from liquids and solids.



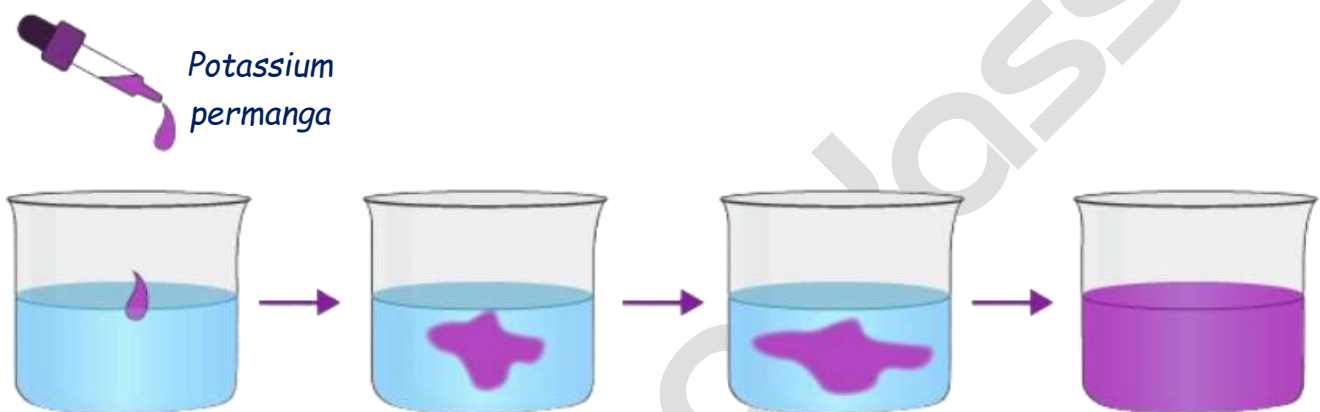
Third: Diffusion

Activity: Demonstrating Diffusion

Tools: Water - Potassium permanganate - Glass beaker

Steps:

- Put water into the beaker.
- Slowly add potassium permanganate crystals.



Observation:

- Potassium permanganate crystals diffuse gradually into the water.
- This demonstrates that substances diffuse from an area of high to low concentration.

Conclusion:

Particles of matter move from a high concentration to a low concentration.

Diffusion is very rapid in gases, moderate in liquids, and very slow in solids.

Diffusion speed increases with increasing temperature, as the speed of diffusion depends on the temperature of the diffusion medium.

Lighter particles diffuse faster.

Diffusion

The movement of particles of matter from a high concentration to a low concentration.

The particle model of matter

Imagine yourself on a journey through matter, moving among tiny units called *particles*.

These particles:

- ✓ make up all the matter around us, such as water, air, and metals.
- ✓ They resemble tiny balls that move and collide.
- ✓ Particles may be *monoatomic or polyatomic*.
- ✓ A polyatomic molecule consists of two or more atoms bonded together by chemical bonds, such as:

A water molecule (H_2O): composed of two hydrogen atoms and one oxygen atom.

An oxygen molecule (O_2): two oxygen atoms.

G.R? The properties of matter vary according to its physical state due to the behavior of its particles.

Particle Theory of Matter

Scientists always try to explain various natural phenomena by making assumptions in an attempt to understand how things work. When these assumptions succeed in explaining many phenomena, they become a *scientific theory*.

One of the theories that has successfully explained much of the *behavior and properties of matter* is the particle theory of matter.

Particle Theory of Matter

A scientific theory developed by scientists to explain the behavior and properties of matter.

Particle Theory Assumptions

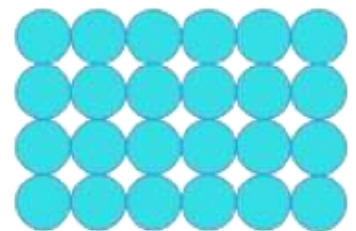
- ❖ Matter is composed of tiny particles that are **invisible to the naked eye**.
- ❖ Particles of a single substance are **identical**, but they differ from one substance to another.
- ❖ There are attractive forces between particles, and **potential energy** is stored due to the attractive forces between them.
- ❖ There are **distances** between particles that vary depending on their physical state.
- ❖ The particles that make up matter have kinetic energy, as they **move constantly in straight lines**.
- ❖ Their speed and method of movement vary depending on the physical state of the substance.

Interpreting the Properties of the States of Matter in Light of Particle Theory

The properties of the states of matter vary depending on the attractive forces between their particles.

In the solid state

- The attractive forces between the particles are so strong that they are tightly bound together.
- The distances between them are very small.
- Particles cannot move from one location; they vibrate in one location without moving to another.
- Volume and shape are constant.

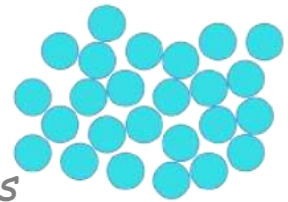


Why...? A solid has a definite shape and volume.

Because the distances between them are very small, the particles cannot move from their position, but rather vibrate in their position without moving to another position.

In the liquid state

- ✚ The attractive forces between particles are relatively weak, allowing them to move freely, but sufficient to hold them together.
- ✚ The distances between particles are relatively larger than in solids.
- ✚ It takes the shape of its container and its volume is constant.

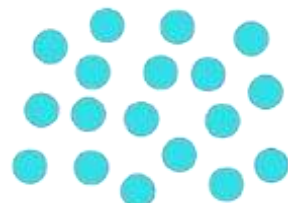


Explain...? A liquid's ability to flow and take the shape of its container?

Because the distances between particles are relatively large.

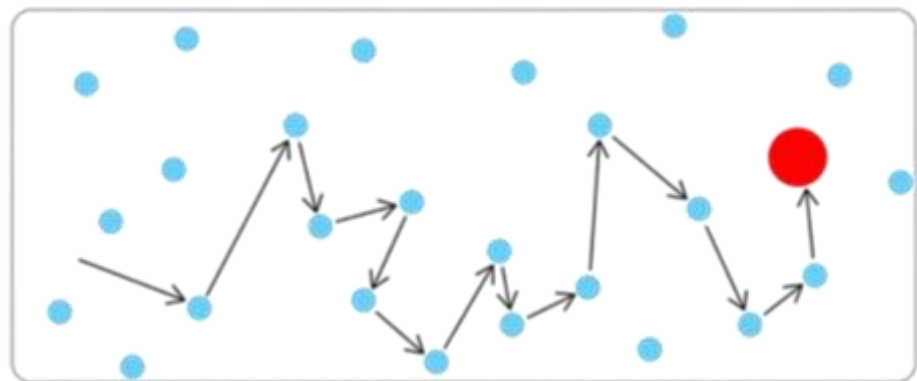
In the gaseous state

- ✚ The attractive forces between particles are very weak, so gas particles move randomly and freely.
- ✚ The distances between particles are very large.
- ✚ It takes the shape and volume of its container and is compressible.



The Brownian Motion Phenomenon

The collision of fluid particles (gas or liquid) with relatively large particles, such as dust in the air or pollen grains in water, causes them to move randomly in all directions.



This phenomenon is known as **Brownian motion**.

Named after **Robert Brown**, its discoverer.



Explain...? The ability of a gas to diffuse and take the shape and size of its container?

Due to the phenomenon of Brownian motion, gas particles collide with relatively large particles, such as dust in the air or pollen grains in water, and they move randomly in all directions.

Explain...? The compressibility of gases?

Gasses can be compressed because the large distances between the particles allow the volume of the gas to decrease by increasing the pressure applied to it. However, the volume of the particles themselves does not change.

	Attractive forces	Shape and Volume	Spaces between particles	Movement of particles
Solid	Very strong	Constant shape and volume	Very small	Vibrate in place
Liquid	Relatively weak	Shape of the container, constant volume	Larger than solid	Flow freely
Gas	Very weak	Shape and volume of the container, compressible	Large	Random and fast

Modeling: A method that provides a simplified representation of very small objects that we cannot see with the naked eye, or very large objects that we cannot perceive. This helps us understand objects and understand the relationships between them.

Use materials from the environment to create models, such as: cork balls, liquid, lentil or rice grains, and computer programs.

Design models of the three states of matter (solid, liquid, and gas) and discuss them with your classmates.

Plasma

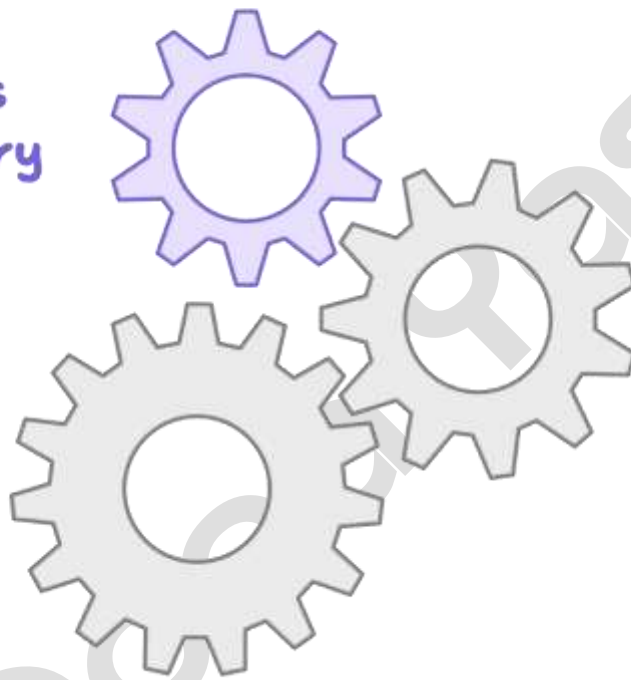
is a state in which gases ionize into positively charged ions and negatively charged free electrons. It is the **fourth** state of matter.

How is plasma formed?

When a gas gets very very hot

And it turns into a soup of charged particles

The atoms lose their electrons



💡 Where can we find plasma?



The Sun
Full of Plasma



Lightning
A plasma flash



Neon Signs
Plasma glowing in colors

⚡ Fun Fact: Plasma is the most common state of matter in the universe!

Plasma state characteristics:

- ⚡ Very high electrical conductivity.
- ⚡ It consists of positively and negatively charged particles.

The Aurora Borealis

A luminous phenomenon that appears at the poles as a result of particles colliding with the atmosphere.



Where can the aurora be observed?

And what does it look like?

Answer: The aurora is observed in areas near the North Pole (such as Norway, Canada, Alaska, and the South Pole). It appears as colorful, undulating lights in the sky, often green, pink, or purple.

Why do aurorae occur in these regions?

Due to the collision of charged particles coming from the sun with the Earth's atmosphere.

This collision gathers in the polar regions due to the shape of the Earth's magnetic field, which directs the particles toward the poles.

Why don't they appear in other regions?

Because the Earth's magnetic field focuses the charged particles toward the poles, preventing them from reaching other regions, such as the equator or the center.

Technological Application - Plasma Air Conditioning

Plasma technology is used in:

Improving indoor air quality.

Mechanism of Operation

- Gases are passed through a high electric field.



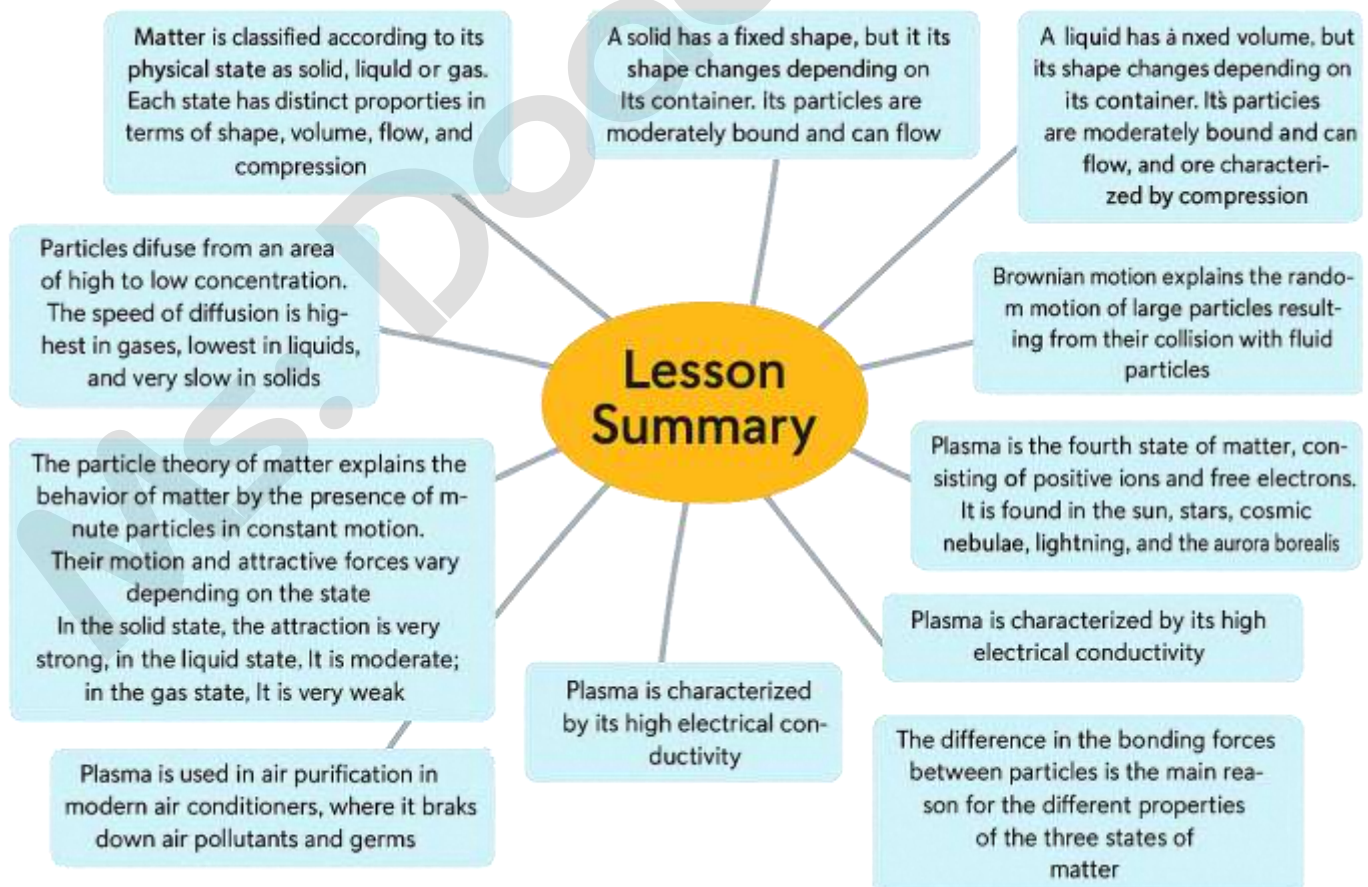
- Their atoms are transformed into charged plasma (positively charged ions and negatively charged free electrons).
- These charged ions break down harmful air pollutants and viruses.

The result is clean, germ-free air.

Discussion Issue

Can the use of plasma air conditioners be made widespread to achieve technological equity?

Yes, this technology should be made available to everyone, especially in hospitals, schools, and crowded areas. However, the high cost may prevent its widespread use among all segments of the population. Therefore, it must be supported by the government or manufactured locally to reduce costs.



Questions

Put a check mark (✓) or an (X) in front of the following statements:

- (1) Particles in solids move randomly in all directions.
- (2) Particle theory assumes that matter contains minute particles in constant motion.
- (3) In gases, the attractive forces between particles are very strong.
- (4) Plasma consists of charged particles and is found in stars and the sun.
- (5) Plasma is used to purify the air inside modern air conditioners.

2. Choose the correct answer for each of the following statements:

(1) What explains the behavior of matter according to particle theory?

- a) Shape of Matter
- b) Particle motion only
- c) Particle behavior, attractive forces, and distances
- d) Type of chemical bonds only

(2) In the gaseous state, the particles are

- a) Strongly cohesive
- b) separately separated and moving freely
- c) static
- d) close together and vibrate.

(3) Plasma is a state of matter characterized by

- a) High electrical conductivity
- b) Large interparticle distances only
- c) slow vibrational motion
- d) strong attraction between particles

(4) Brownian motion occurs as a result of

- a) heating materials
- b) collides large particles with fluid particles
- c) Freezing of molecules
- d) Formation of chemical bonds

5) Plasma technology is used in air conditioning because it:

- a) Reduces temperature only
- b) Prevents dust from entering
- c) Decomposition of air pollutants and viruses
- d) The percentage of oxygen in the atmosphere increases

Write the scientific term:

- (1) The theory that explains the behavior of matter in light of the motion of its particles, the forces of attraction, and the distances between them.
- (2) Particles composed of two or more atoms bound by chemical bonds.

- (3) Random motion that occurs when particles of a fluid collide with tiny particles suspended in it.
- (4) A state of matter consisting of positive ions and free negative electrons.
- (E) A light phenomenon that appears in polar regions as a result of solar particles colliding with the atmosphere.

Give Reason:

(1) The properties of matter differ from one state to another?

(2) Difficulty to break a piece of solid rock?

(3) Candle smoke spread through the air?

(4) Using plasma technology in air purifiers?

(5) The aurora borealis only appear in regions near the poles?

Extract the missing word and then write what connects the remaining words:

(1) Particles - Chemical bonds - Heat - Interstices

(2) Molecules - Atoms - Electrons - Ions

(3) Plasma - Dust - Aurora Borealis - Lightning

(4) Kinetic energy - Attraction - Photons - Interstices

(5) Air purification - Plasma screens - Brownian motion - Air conditioners

What happens in the following cases:

(1) The interstices between particles in a substance increase?

(2) Fluid particles collide with fine solid particles such as pollen grains?

(3) When gas atoms are ionized?

(4) When gases pass through plasma air conditioners?

(5) When charged particles from the sun collide with the atmosphere at the poles?

Q: Give one example:

(1) A substance whose particles consist of multiple atoms linked by chemical bonds.

L2: Change State of Matter

ready



We previously learned that matter exists in three states: solid, liquid, and gas. Matter can change from one state to another by *losing* or *gaining* thermal energy.

We will conduct the following activity to observe the transformations of matter from one state to another.

Activity: Transformation of matter from one state to another

Equipment: Glass beaker, pieces of ice, heat source, thermometer, stirring rod.

Steps	Illustration	Note
Place the ice cubes and thermometer in the cup, then heat it gently with a heat source.		Ice begins to melt at zero degrees Celsius: it changes from a solid to a liquid state.
Stir at even intervals and record the thermometer reading each time until the ice is completely melted.		
Continue heating, recording the water temperature at equal intervals until the water reaches a boil.		The temperature gradually rises until it reaches the boiling point, at which the change from the liquid state (water) to the gaseous state (water vapor) begins.
Let the water boil for several minutes, then record the thermometer reading.		

Record the thermometer reading in the table below.

Draw a graph representing the change in water temperature during heating over time in minutes.

t	1	2	3	4	5	6	7	8	9
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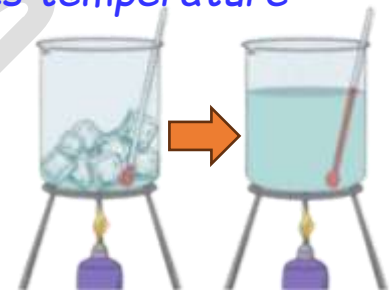
From the previous activity, we conclude the following:

Melting Ice

When ice gains a certain amount of thermal energy, its temperature gradually rises until it reaches its melting point of 0°C (at normal atmospheric pressure).

At the melting point, the ice (solid state) begins to transform into water (liquid state).

The temperature **remains constant** until complete melting.

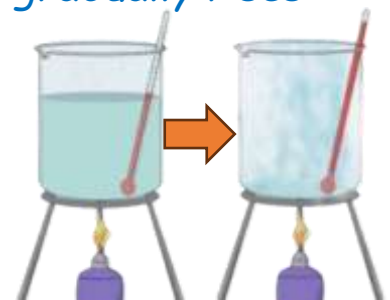


Melting Point: The temperature at which a substance changes from a solid to a liquid state.

Boiling Water

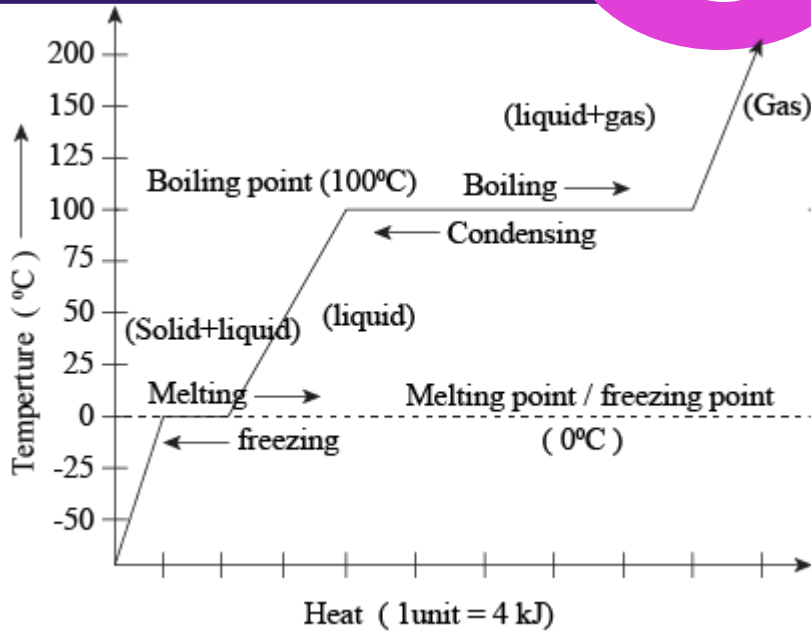
As water gains more thermal energy, its temperature gradually rises until it reaches its boiling point of 100°C (at normal atmospheric pressure).

The temperature of water and its vapor **remains constant** until complete evaporation.

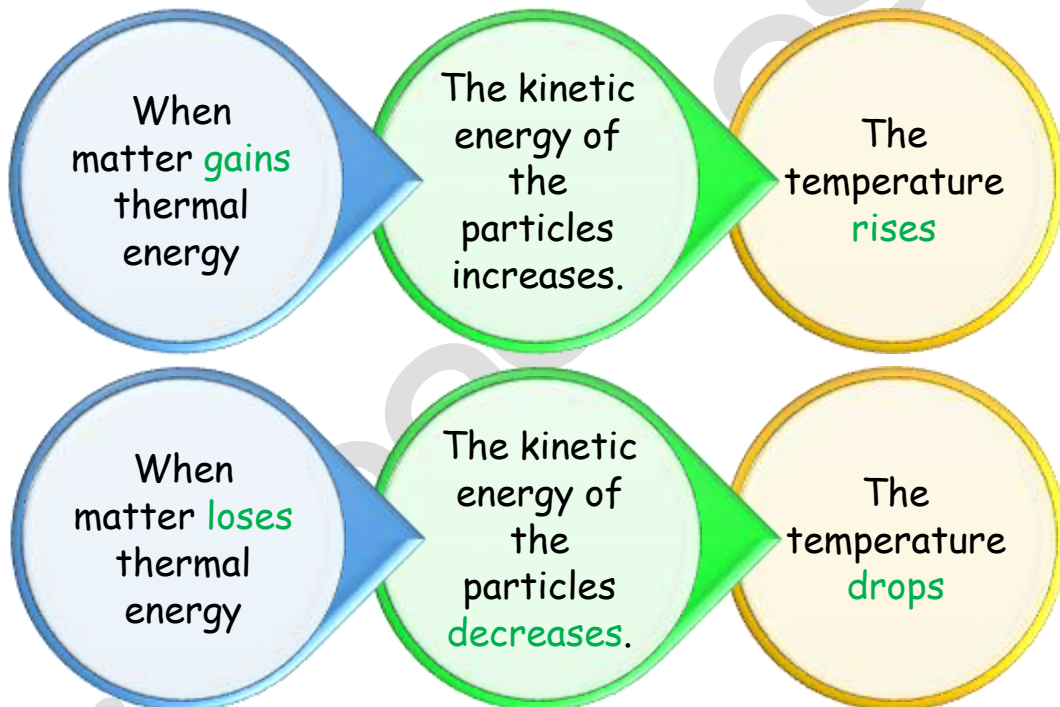


Boiling Point: The temperature at which a substance changes from a liquid to a gaseous state.

The following figure shows the heating curve of water in its three states under specific conditions.



During the processes of melting and boiling, the temperature of the substance remains constant, and the thermal energy gained by the substance weakens the forces of attraction between the particles of the substance, so the substance changes from one state to another.



Factors Affecting the Melting and Boiling Points of a Substance

Every substance has a fixed melting and boiling point at normal atmospheric pressure.

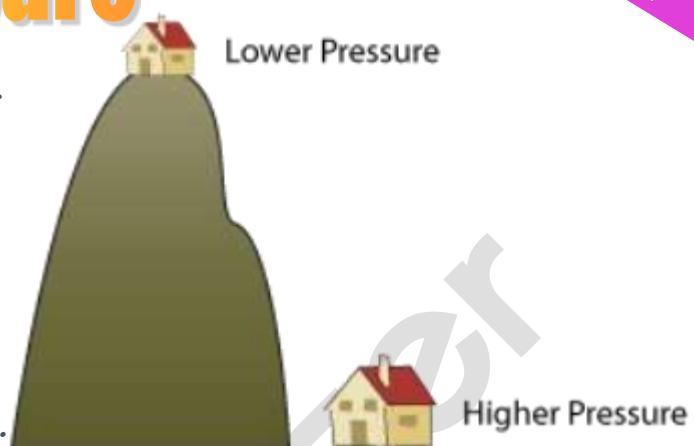
Our melting and boiling points are affected by several factors, including:

- 1) Atmospheric pressure
- 2) Purity of the substance



Atmospheric pressure

We previously learned that atmospheric pressure represents the weight of a column of air above a given area on the Earth's surface, and that the value of atmospheric pressure varies from one place to another on the Earth's surface.



Under normal atmospheric pressure conditions (at sea level)

Pure water boils at 100°C .

Pure water freezes at 0°C .

Changes in atmospheric pressure affect the melting and boiling points of pure water as follows:

When the atmospheric pressure is higher than normal atmospheric pressure



The boiling point of water increases above 100°C and the freezing point (melting of ice) decreases below 0°C

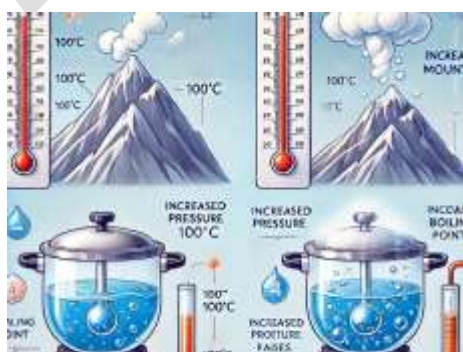
When the atmospheric pressure is lower than normal atmospheric pressure



The boiling point of water decreases below 100°C

With higher altitudes in mountainous regions, the atmospheric pressure gradually decreases, and thus the boiling point of water decreases.

For every 300°C above sea level, the boiling point decreases by approximately 1°C



Example

If the boiling point of pure water at sea level is 100°C , what is the approximate boiling point of water at a point at an altitude of 900m?

Amount of decrease in boiling point of water =

$$\text{elevation} / 300 = 900 / 300 = 3^{\circ}\text{C}$$

Boiling point of water at a point at an elevation of 900 m

$$100 - 3 = 97^{\circ}\text{C}$$

The boiling point of pure water decreases as you ascend a mountain.

This is because atmospheric pressure decreases as you ascend a mountain, and thus the boiling point decreases.

Technological Applications: Pressure Cooker



Pressure cookers trap water vapor inside the cooker during cooking. This results in increased pressure, which leads to:

1. A higher boiling point for water than in a conventional pot.
2. A shorter cooking time, which helps save fuel.

It is not preferable to use a pressure cooker for cooking.

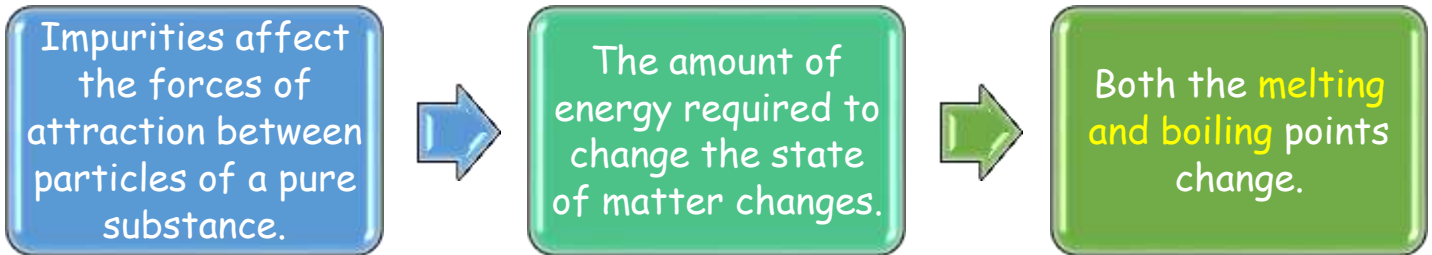
Because it increases the pressure inside, the boiling point of the water increases, reducing cooking time, which helps save fuel.

Purity of substance

Every pure substance has a fixed melting and boiling point at normal atmospheric pressure. Changes in the purity of a substance affect its melting and boiling points.

	1 liter of distilled (pure) water	1 liter of distilled water + 342 grams of glucose
Boiling point	100°C	100.5°C
Freezing point	0°C	-1.86°C

What happens when there are impurities in a substance?



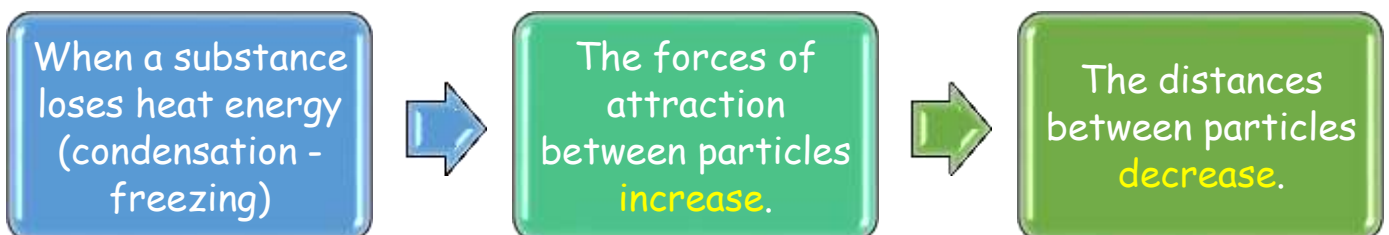
Matter transformations are reversible processes.

Matter can change from one state to another. This occurs by losing or gaining a quantity of thermal energy, and occurs through certain processes, such as condensation, freezing, melting, and boiling.

Heat energy loss

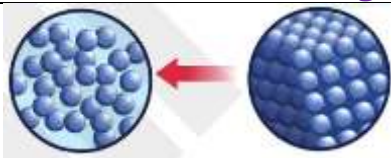
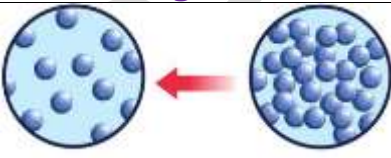
A substance loses heat energy and its temperature decreases during condensation and freezing processes, as follows:

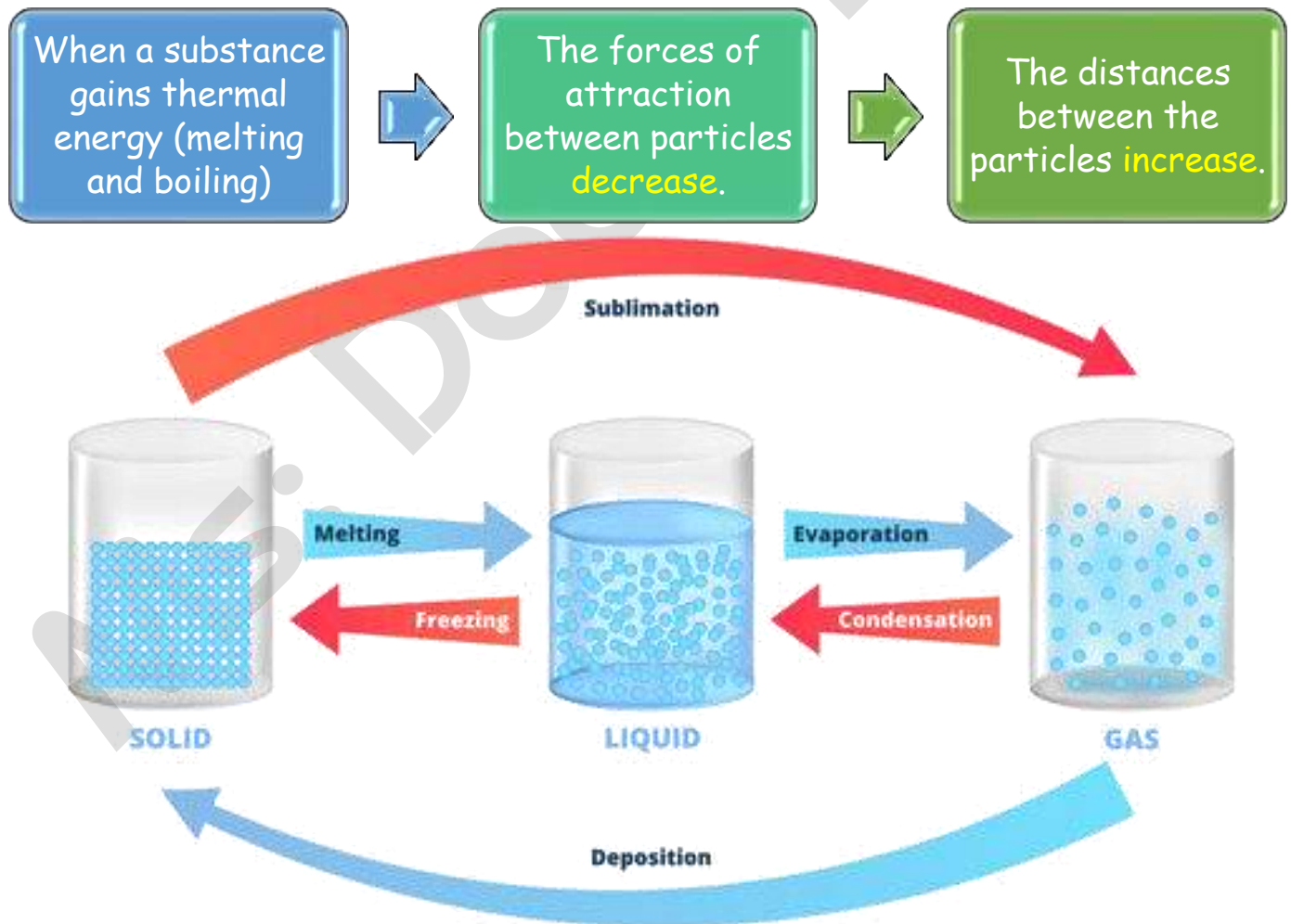
Condensation	Freezing
The transformation of a substance from a gaseous state to a liquid state.	The transformation of a substance from a liquid state to a solid state
1. Dew forms on plant leaves in the early morning. 2. Water droplets form on a cold glass surface.	1. Water freezes in a refrigerator cooler. 2. Ice cream freezes in a refrigerator cooler.



Heat Energy Gain

A substance gains heat energy and its temperature rises during the processes of melting and boiling, as follows:

Melting	Boiling
The transformation of a substance from a solid to a liquid state by gaining heat energy through heating or from the surrounding medium.	The transformation of a substance from a liquid to a gas state by gaining heat energy through heating.
Ice Cream Melting	Boiling water
	



Matter loses thermal energy, thus decreasing the kinetic energy of particles.

From the above, we conclude that:

- Melting is the opposite of freezing, while evaporation is the opposite of condensation.

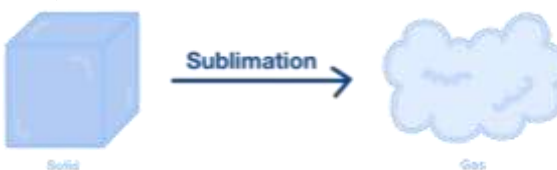
The transformation of a substance from one state to another represents a physical change.

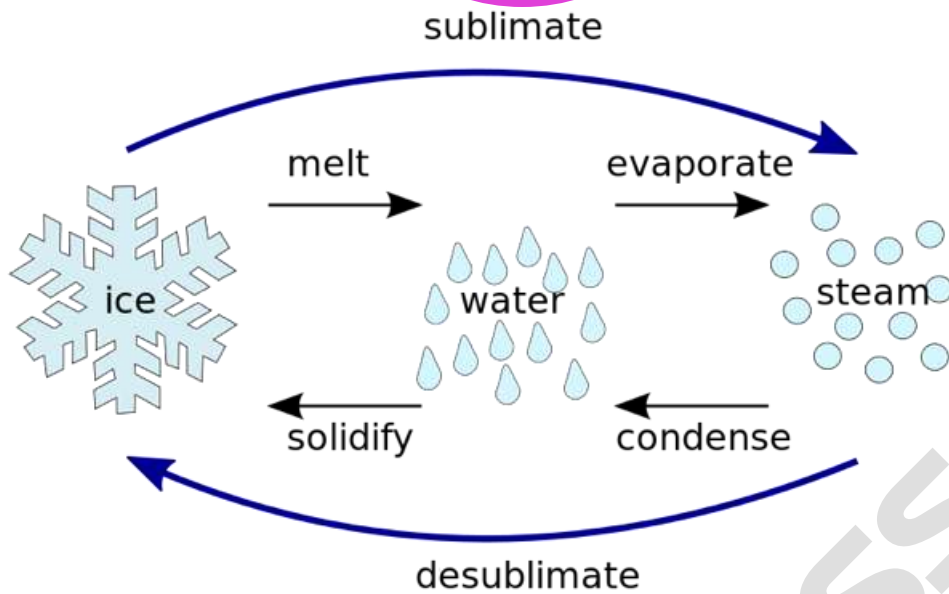
Because the transformation of a substance from one state to another is not accompanied by a change in the composition of its molecules or the formation of new substances.

For example, water molecules (H_2O) do not dissociate into hydrogen and oxygen molecules when it changes from one state to another.

- The change that occurs in the composition of a substance and produces new substances is known as a chemical change.

There are other forms of reversible processes that do not pass through the liquid state, such as sublimation and deposition.

Sublimation	Deposition
The transformation of matter from the solid state to the gaseous state directly without passing through the liquid state.	The transformation of matter from the gaseous state to the solid state directly without passing through the liquid state
Dry ice sublimates. Dry ice is solid carbon dioxide. Iodine sublimates.	Frost formation
	



What happens when...? Water vapor molecules in the air lose thermal energy.

This leads to water vapor condensing into fog, dew, or clouds.

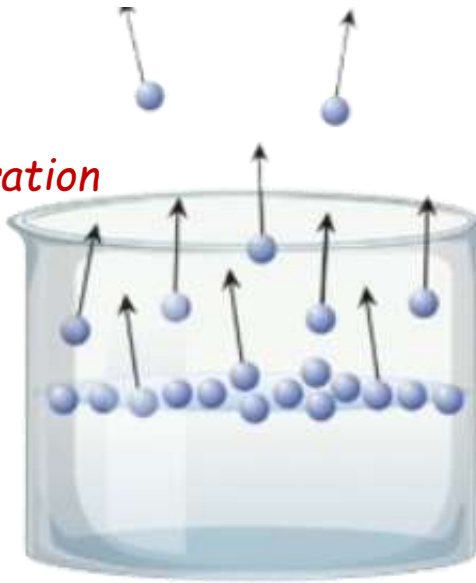
Boiling & Evaporation



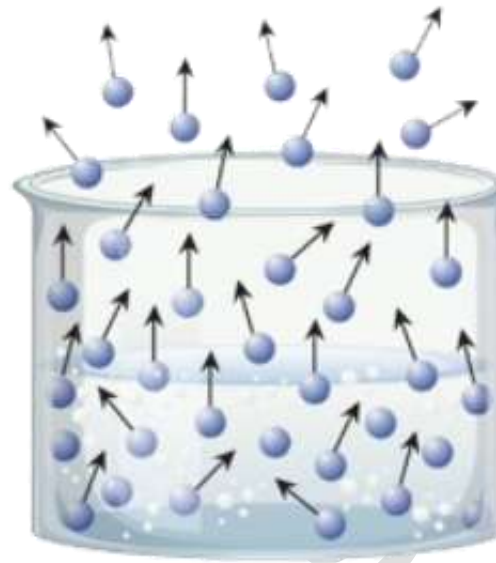
The process of evaporation of water differs from the process of boiling as follows:

Evaporation	Boiling
Water evaporates at temperatures below its boiling point. Evaporation occurs at the surface of the water without the formation of air bubbles. These molecules gain thermal energy from the surrounding environment. They are freed from the attractive forces of other water molecules and are released into the air, transforming into a gaseous state.	A liquid turns into vapor at a specific temperature called its boiling point. At boiling point, the bonds between the molecules of a liquid are broken throughout its entirety.

Evaporation



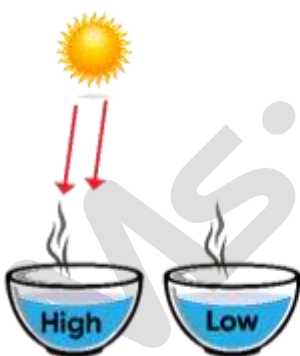
Boiling



Boiling point is a property of pure substances, not evaporation.
Boiling point occurs at a specific temperature for each pure substance, while evaporation occurs at any temperature.

DIFFERENT FACTORS AFFECTING EVAPORATION

Temperature



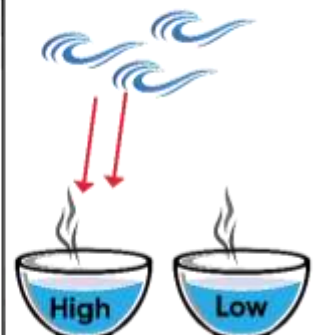
Surface area



Humidity



Wind speed



When the temperature increases, the rate of evaporation

When the surface area of the liquid exposed to the air increases,

When the humidity (water vapor) in the air increases, the evaporation rate decreases.

When the speed of air currents increases, the rate of evaporation

As the temperature increases, the kinetic energy of the molecules increases, increasing the number of molecules with enough energy to escape from the liquid surface.

As the surface area of the liquid exposed to air increases, the number of molecules that can gain thermal energy from the surrounding medium and escape from the liquid surface increases.

1- Wet clothes dry faster during the day when the sun is shining than at night.

Due to the increased rate of water evaporation when temperatures rise.

2- Feeling uncomfortable in hot, humid weather.

Due to the increased water vapor content in the air, sweating and water evaporation from the body decrease, increasing the sensation of heat.

Integration with Hydrology

The transformation of water from one state to another, such as evaporation, condensation, freezing, and melting, are fundamental processes in the natural water cycle.

The natural water cycle directly affects many weather factors.

Technological Application: Instant Coffee

Manufacturing Method: Concentrated coffee syrup spray is exposed to extremely hot, dry air (about (250) degrees Celsius), which increases the surface area of the spray balls exposed to the hot air. **The evaporation rate increases, and solid instant coffee crystals form.**

Instant coffee is so named? because it dissolves quickly in water compared to regular coffee.

Questions

Choose the correct answer:

1. Boil water at a temperature of
 0°C 25°C 100°C 125°C
2. Ice melts at a temperature of
 0°C 20°C 50°C 125°C
3. Factors affecting the melting and boiling points of a substance
 (a) Number of particles (b) Particle size
 (c) Atmospheric pressure (d) the amount of substance
4. The kinetic energy of the particles of a substance increases with
 (a) Heat loss (b) Cooling
 (c) Heating (d) Freezing
5. When ice is heated, the temperature remains constant at 0°C until
 (a) the ice evaporates (c) the ice melts completely
 (b) Boiling is complete (d) Bubbles form
6. When water is placed in a freezer, the kinetic energy of the particles
 (a) Increases (b) Disappears
 (c) Decrease (d) Remain constant
7. When a substance begins to boil, its temperature
 (a) increases rapidly (b) Decreases suddenly
 (c) Remain constant (d) Disappear
8. If the boiling point of pure water at the foot of a mountain 100°C The boiling point of water at the top of a mountain, which is 3 Km high equals
 (a) 110°C 99°C 100°C 90°C
 (1) remains constant.
9. If the substance contains impurities and becomes impure, its boiling point
 a) Remain constant (b) rises
 (c) decreases (d) rises and then falls.
10. The boiling point of pure water at the top of a mountain its boiling point at the Earth's surface.
 (a) is less than (b) equals
 (c) doubles (d) greater than
11. The lower the thermal energy of a substance, the kinetic energy of the particles that make it up.
 (a) increases (b) decreases
 (c) does not change (d) disappears

Put a check mark (✓) or (X):

1. The state of matter changes with a change in temperature.
2. A substance changes from a gaseous state to a liquid state when it loses thermal energy.
3. The kinetic energy of ice particles is greater than the kinetic energy of water particles...
4. The boiling point of a pure substance is constant under the same atmospheric pressure.
- All solids melt at the same temperature.
- Pure substances have a constant boiling point.
7. The purity of a substance can be determined by its melting and boiling points.
8. The boiling point of a substance depends only on its purity.
9. The higher the atmospheric pressure, the higher the boiling point of a liquid.
10. The boiling point of pure water inside a deep well is higher than the boiling point of pure water at the Earth's surface.

Write the scientific term that represents the following expressions:

1. The temperature at which a substance changes from a solid to a liquid state.
2. A substance changes from a liquid to a gaseous state when thermal energy is gained.
3. A substance changes from a liquid to a solid state when thermal energy is lost.
4. A substance changes from a gaseous state to a liquid state when thermal energy is lost.
5. A substance changes from a solid to a gaseous state directly.

G.R for the following:

- 1 The boiling point of water at the top of a mountain differs from its boiling point at sea level.
.....
- 2 Salt water is not used in experiments to measure the boiling point of water.
.....
3. Water boils at a temperature below 100°C at the top of Mount Everest.
.....
4. Cooking time is reduced when using a pressure cooker.
.....

Internal Energy & Temperature

1) Types of system and temperature.

In our daily lives, we often deal with objects that we heat or cool, and during this process, a change in both matter and energy occurs.

For example: When heating a cup of tea, we observe

- The water vapor rising upwards, representing a change in matter.
- The temperature of the tea drops after a period of time, representing a change in energy.



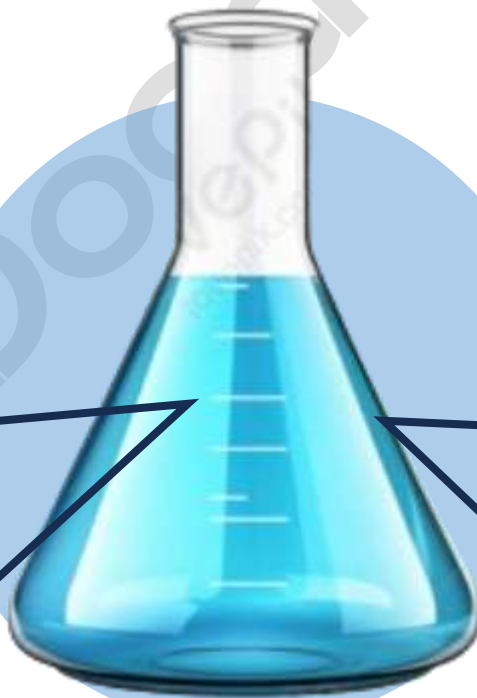
To understand what happens, we need to understand two basic concepts in physics: system and temperature.

System

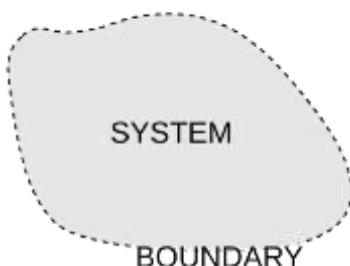
Any part of the universe that is the subject of study and observation of the changes in matter and energy within it.

System boundary

The envelope that surrounds the system and separates it from its surroundings. It can be real or imaginary.



SURROUNDINGS

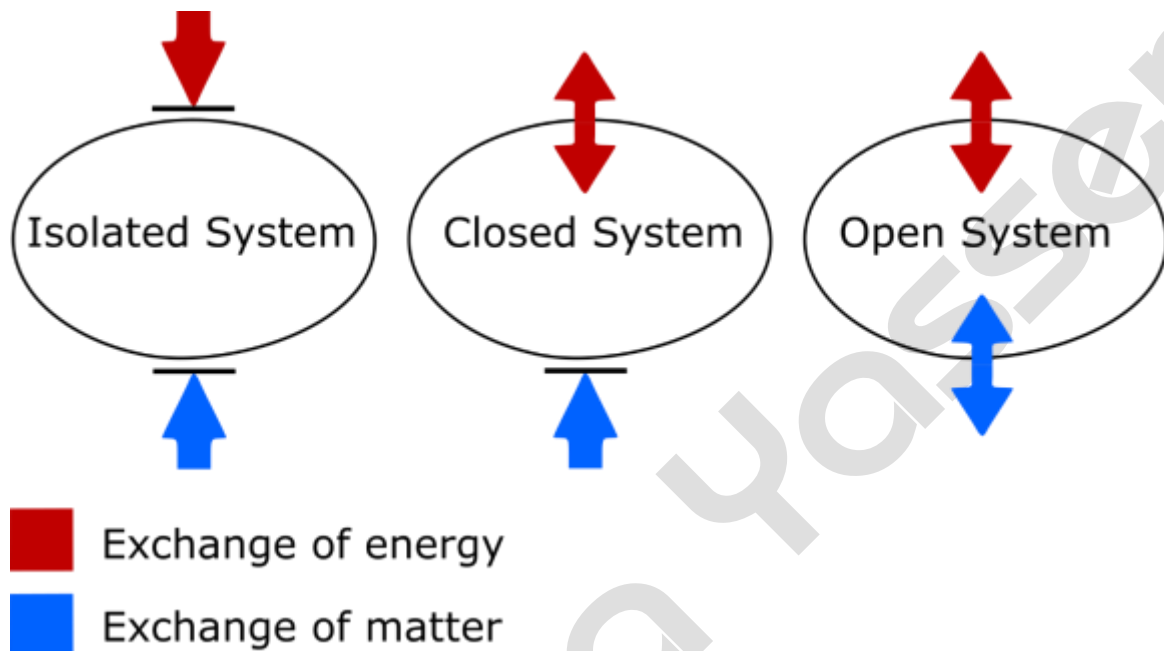


The surrounding environment

Everything surrounding a system outside its boundaries and that may interact with it.

Systems Types

- Systems are classified based on the ability to exchange energy and matter between the system and its surroundings.



Open system	Closed system	Isolated system
A system in which energy and matter are exchanged with the surrounding environment.	A system in which only energy is exchanged with the surrounding environment, not matter.	A system in which no exchange of energy or matter occurs with the surrounding environment.
An open pot containing boiling water represents an open system... Explain? Because heat and water vapor are exchanged with the air.	A soft drink can represent a closed system... Explain why? Because only heat is exchanged within it, without any material being exchanged with the air.	The thermos represents an isolated system... Explain why? Because no exchange of heat or matter occurs in it with the surrounding environment.

Internal Energy of a System

According to the **particle theory of matter**, any system consists of matter, whether **solid, liquid, gas**, or a mixture thereof.

This matter consists of very small particles, each of which has **kinetic and potential energy**. The sum of these is known as the **internal energy of the system**.

Internal energy of a system: The sum of the kinetic and potential energies of all the particles in the system.

Factors affecting the internal energy of a system:

1) Kinetic energy of its particles 2) Potential energy of its particles

The internal energy of a system **increases** with the **increase** in the kinetic energy of its particles, its potential energy, or both.

The potential energy of solid particles is at its **highest**, while the potential energy of gaseous particles is **almost zero**.

System Temperature

A measure of the average kinetic energy of the system's particles.

The temperature of a system expresses how **hot or cold** it is.

When the average kinetic energy of the particles in a system increases, the temperature of the system increases.

Example: The average kinetic energy of hot water particles is greater than the average kinetic energy of cold water particles.



$$\text{Average kinetic energy of particles} = \frac{\text{Total kinetic energy of particles}}{\text{Number of particles}}$$



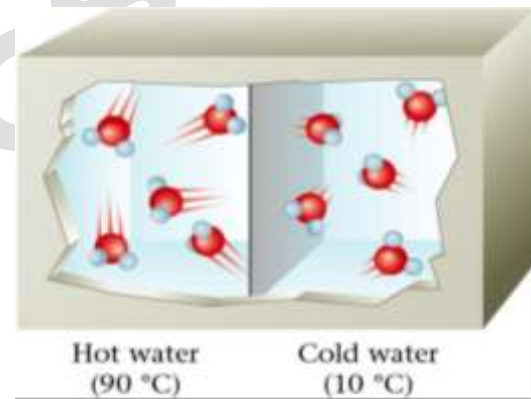
The average kinetic energy of the particles in a system equals the kinetic energy of a single particle when the kinetic energy of all particles is equal.

Matter is considered a system containing particles, and changes in the internal energy of a substance affect its temperature.

The internal energy of a solid system increases when it gains thermal energy. This is because the particles in the system begin to vibrate more rapidly, increasing their kinetic energy and, consequently, the internal energy of the system.

2) Factors affecting the change in body temperature.

Heat transfer from or to a body (system) is inferred from the change in its temperature as follows:



When the system gains thermal energy



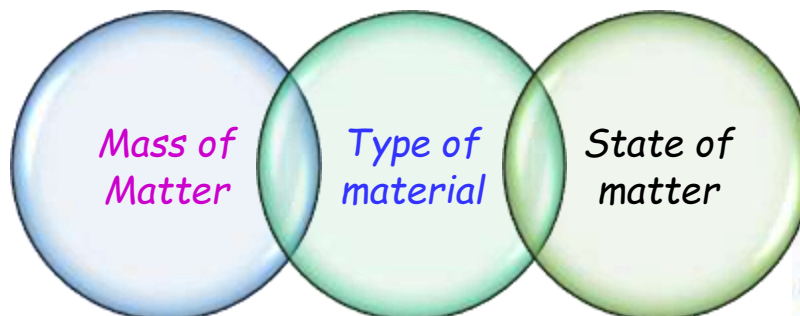
Temperature increases

When the system loses thermal energy



Temperature decreases

Factors that affect the amount of change in the temperature of a body or system when it gains or loses thermal energy:



Mass of Matter

To know the **effect of the mass** of a substance or system on the rate of change in the temperature of the body or system when it gains or loses an amount of thermal energy, we conduct the following activity:

Activity: The effect of mass of matter on the rate of change in temperature

Tools: Two different masses of water in two glasses (A), (B) - two thermometers - a heat source (a flame) - a stand - a stopwatch

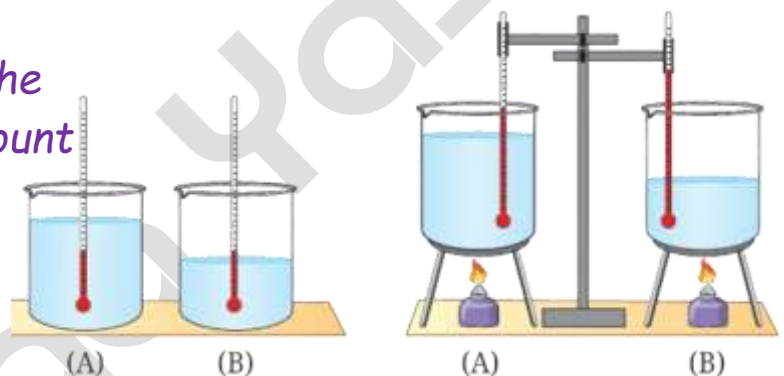
Steps

Use a thermometer to measure the temperature of the water in each cup before heating.

Make the flame even so that the heating time measures the amount of heat the water gains.

Heat both cups for the same amount of time.

Record the thermometer reading in each cup after heating is complete.



Note: The amount of change in the temperature of the water in cup (B) (the one with the least mass) is greater than the amount of change in the temperature of the water in cup (A) (the one with the greatest mass).

Conclusion: The amount of change in temperature of different masses of the same substance varies when they gain or lose the same amount of thermal energy.

The amount of change in temperature of a substance increases the smaller the mass of the substance, and vice versa.

In the previous activity:

The independent variable is the mass of water.

The dependent variable is the rate of change in temperature.

The control variable is the heating time—the amount of heat gained.

The amount of change in a substance's temperature increases the lower the mass of the substance.

Because the thermal energy gained by the substance is distributed among fewer particles, its average kinetic energy increases by a greater amount.

Second: Type of Matter

To understand the effect of the **type of matter** or system on the rate of change in the temperature of a body or system when it gains or loses a quantity of thermal energy, we conduct the following activity:

Activity: The effect of the type of material on the rate of change in temperature

Tools: Two equal masses of water and oil in two beakers (A) and (B) -
Two thermometers - A heat source (flame) - A stand
- A stopwatch

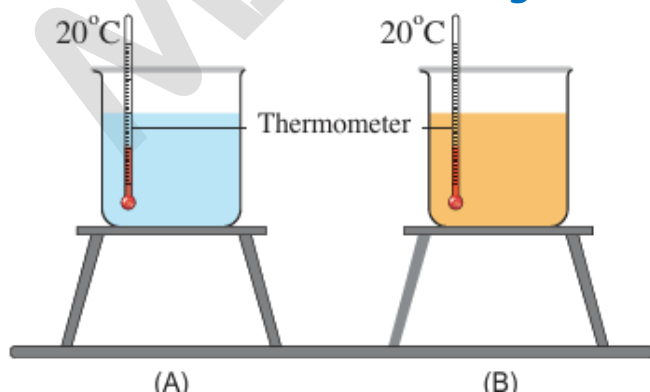
Steps

Use a thermometer to measure the temperature of the water and oil (Figure 1).

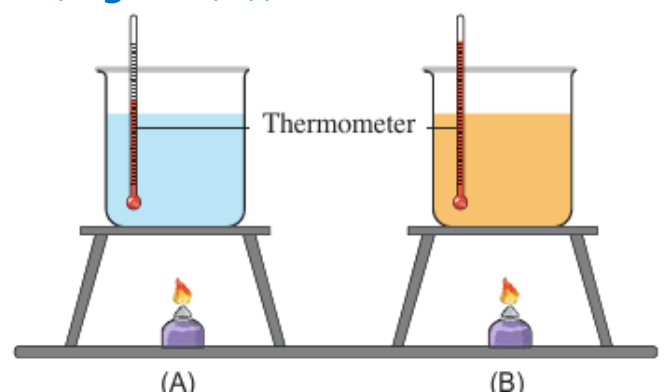
Keep the flame steady so that the heating time measures the amount of heat gained by both the water and oil.

Heat the water and oil for the same amount of time.

Record the thermometer readings in both the water and oil after heating is complete (Figure (2)).



(Figure (1))



(Figure (2)).

Note

The change in temperature of the oil in cup (B) is greater than the change in temperature of the water in cup (A).

Conclusion

The temperature change of equal masses of different materials varies when they gain or lose the same amount of heat energy.

The temperature of a mass of oil rises by a greater amount than that of an equal mass of water when it gains the same amount of heat energy.

In the previous activity,

The independent variable is the type of matter.

The dependent variable is the rate of change in temperature.

The controlling variable is the heating time, the amount of heat gained, and the mass of the substance.

Specific Heat

When we heat two different substances with the same mass, such as water and oil, with the same amount of heat and for the same period of time, we notice that:

The change in the temperature of the oil is greater than the change in the temperature of the water.

This is because each substance has a different ability to retain or absorb heat, a property known as specific heat.

Specific Heat: The amount of heat required to raise the temperature of 1 kilogram of a substance by 1°C .

Specific heat is measured in $\text{J/kg}^{\circ}\text{C}$.

The following table shows the specific heat values for some substances or one of their states.

Matter	Hg	Cu	Fe	Al	Oil	Ice	H ₂ O
J/kg.C	140	385	450	900	2000	2090	4180

G.R

1 - Mercury is used in the manufacture of thermometers.

Because it has a lower specific heat than other liquids, it is sensitive and responsive to temperature changes in thermometers.

2 - Copper is thermally preferable to aluminum in the manufacture of heating utensils.

Because the specific heat of copper is lower than that of aluminum, the temperature of copper rises at a greater rate than aluminum when they absorb the same amount of thermal energy.

3 - Water is a major component of the human body.

Because the specific heat of water is high, it requires a large amount of heat to change its temperature, which maintains a constant body temperature.

My Life App: The Radiator:

Water is an excellent coolant. Why?

Because it has a high specific heat, absorbing large amounts of thermal energy without significantly increasing its temperature.

Therefore, water is used in the cooling system connected to car engines, known as the radiator. Why?

To protect engines from damage.



State of Matter

To understand the effect of the state of matter or system on the amount of change in temperature of a body or system when it gains or loses a quantity of thermal energy, conduct the following activity.

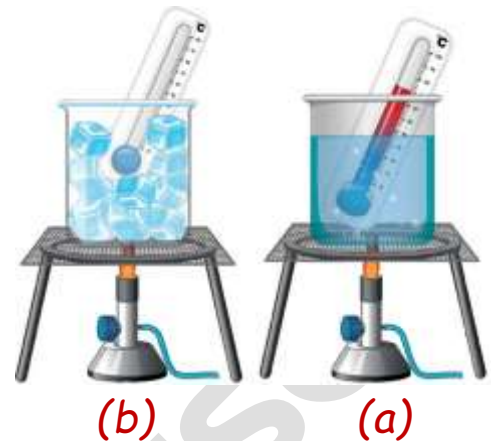
Activity: The effect of the state of matter on the rate of change in temperature

Tools: Two equal masses of water and ice - Two thermometers - A heat source (flame) - A stand - A stopwatch

Steps

Use a thermometer to measure the temperature of the water and ice.
Keep the flame steady so that the heating time measures the amount of heat gained by both the water and ice.
Heat the water and ice for the same amount of time.
Record the thermometer readings in both the water and ice after heating is complete.

Illustration



Note: The change in temperature of the ice in beaker (B) is greater than the change in temperature of the water in beaker (A).

Conclusion

The amount of change in temperature of equal masses of different states of the same substance varies when they gain or lose the same amount of heat energy.

In the previous activity, the temperature of a block of ice increases by a greater amount than that of an equal mass of water when it gains the same amount of heat energy.

In the previous activity,

The independent variable is the state of the substance.

The dependent variable is the rate of change in temperature.

The controlling variable is the heating time, the amount of heat gained, and the mass of the substance.



Questions

Write the scientific term:

- (1) Any part of the universe that is the subject of study and observation of the changes in energy & matter within it (.....)
- (2) The space surrounding a system with which energy, matter, or both can be exchanged. (.....)
- (3) A system in which energy and matter are exchanged with the surrounding environment. (.....)
- (4) A system in which energy is exchanged without matter with the surrounding environment. (.....)
- (5) A system in which neither energy nor matter is exchanged with the surrounding environment. (.....)
- (6) The average measure of the kinetic energy of the particles in a system. (.....)
- (7) The sum of the potential and kinetic energies of the particles in a system. (.....)
- (8) The amount of heat required to raise the temperature of 1 kg of matter by 1 degree. (.....)
- (9) The cooling system connected to a car engine. (.....)

Correct the underlined:

- (1) An open system exchanges energy only with its surroundings. (.....)
- (2) Bottles of mineral water represent an isolated system. (.....)
- (3) Temperature is a measure of the average kinetic energy of the particles of a substance. (.....)
- (4) A decrease in the average velocity of the particles of a substance is offset by a constant temperature. (.....)
- (5) Mercury is an excellent refrigerant. (.....)
- (6) The specific heat of ice is equal to the specific heat of liquid water. (.....)
- (7) Radiators are used to protect car tires from damage. (.....)

Put (✓) or (X):

- (1) An open system is one in which matter is exchanged only with the surrounding medium. ()
- (2) A thermos represents a closed system. ()
- (3) The temperature of a substance is a measure of the average kinetic energy of its particles. ()

- (4) An increase in the average kinetic energy of the particles in a system leads to an increase in its temperature. ()
- (5) The average kinetic energy of the particles in hot water is equal to the average kinetic energy of the particles in cold water. ()
- (6) The average kinetic energy of the particles in a system is equal to the kinetic energy of a single particle, assuming the kinetic energy is equal. ()
- (7) Heat transfer from or to a body is inferred from a change in its temperature. ()
- (8) The amount of change in the temperature of a body increases with an increase in its mass when it gains a quantity of heat. ()
- (9) The specific heat of a single substance varies depending on its physical state. ()

What is meant by each of the following:

- | | |
|----------------------|------------------------------------|
| (1) System. | (6) Temperature. |
| (2) Surroundings. | (7) Internal energy of the system. |
| (4) Closed system. | (8) Specific heat. |
| (3) Open system. | (9) Radiator. |
| (5) Isolated system. | |

Give Reason for:

- (1) A hot cup of tea represents an open system.
-
- (2) A vacuum-packed saucepan represents a closed system, while a thermos represents an isolated system.
-
- (3) A medical thermometer is considered a closed system.
-
- (4) The kinetic energy of the particles of solids is small, while the kinetic energy of the particles of gases is very high.
-
- (5) The temperature of a liquid decreases when it loses thermal energy.
-
- (6) The speed of diffusion of odors in hot air is greater than their speed of diffusion in cold air.
-
- (7) The internal energy of any isolated system is constant.
-

Heat Transfer Methods

Heat Transfer

When you place a cup of hot tea at 70°C in a cold room at 25°C , the tea cools down after a short period of time.

Heat is transferred from the higher-temperature object (the hot tea) to the lower-temperature object (the cold air in the room).



To learn how heat is transferred, conduct the following experiment:

Activity: Demonstrates how heat is transferred

Tools: 2 glasses - Tap water - Thermometer - Metal block suspended from a string - Heat source (such as a stove)

Steps:

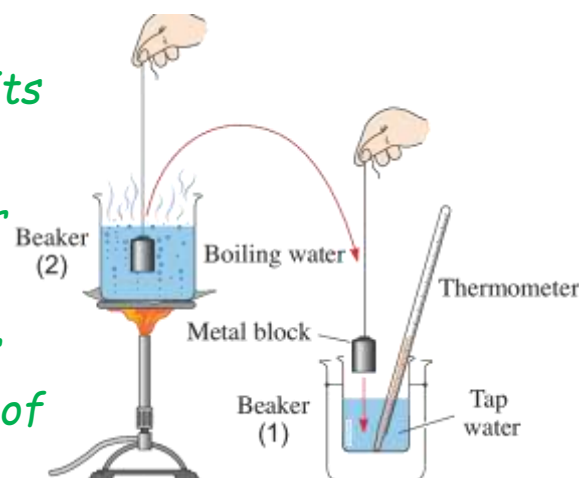
Put tap water in beaker No. (1) and measure its temperature with a thermometer.

Heat another quantity of tap water in beaker No. (2) until it boils.

Immerse the metal block in the boiling water in beaker No. (2), then predict the direction of heat flow.

Move the metal block from the boiling water in beaker No. (2) to the cold water in beaker No. (1), then predict the direction of heat flow. Re-measure the temperature of the water in beaker No. (1) after placing the metal block in it. **What do you notice?**

Heat is transferred from the boiling water in the cup (2) to the metal block.



Heat is transferred from the metal block to the cold water in the cup (1).

The temperature of the tap water in the cup (1) rises after the metal piece is placed inside.

The temperature of the metal piece decreases after it is placed in the tap water.

Conclusion



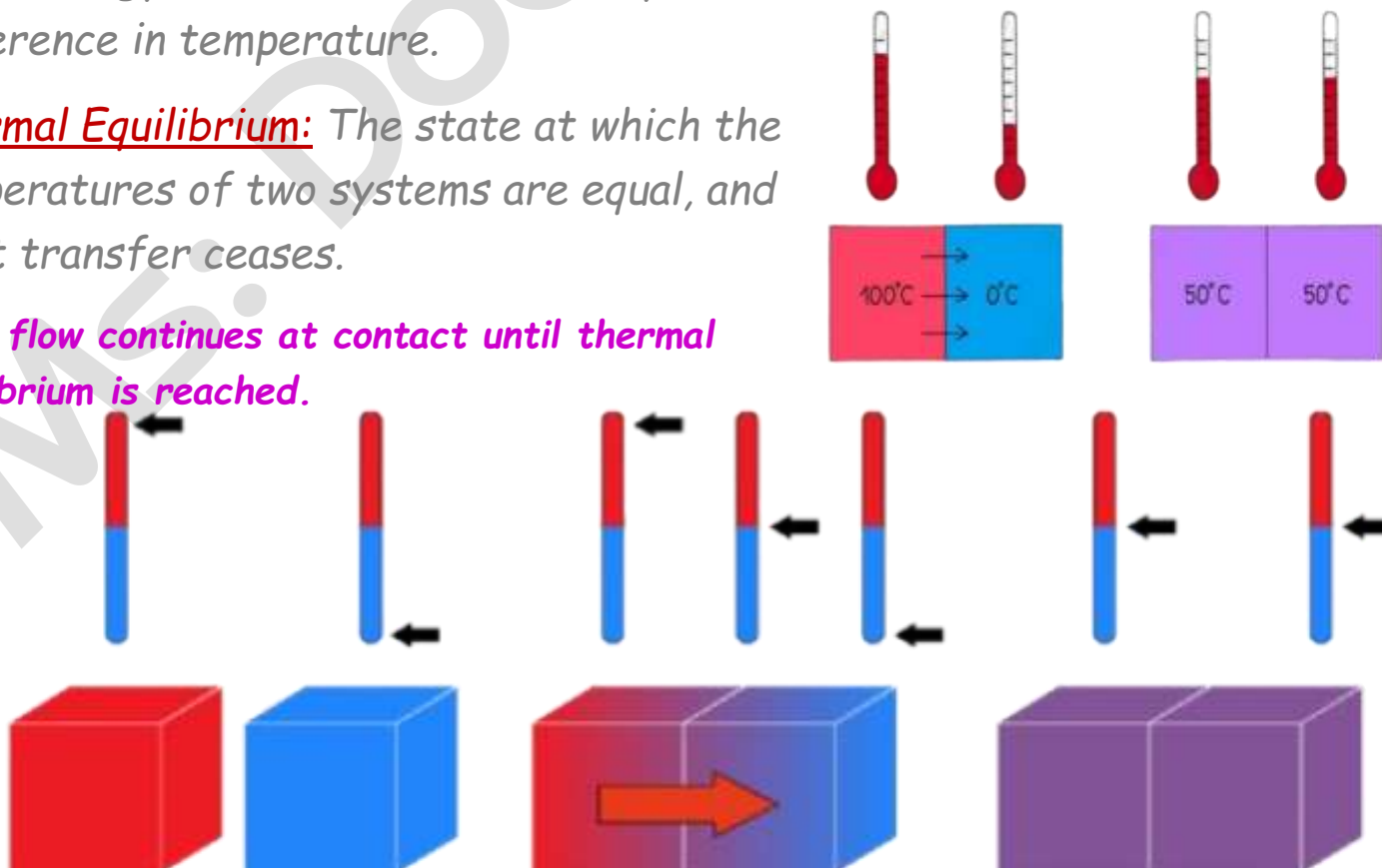
When two non-isolated systems with different temperatures (such as a metal block and water) come into contact, energy is transferred from the **higher-temperature system** to the **lower-temperature system**. Heat transfer continues between them until the temperatures of the two systems are equal.

The energy transferred from one system to another due to a difference in temperature is called **heat**.

Heat: Energy transferred from one system to another due to a difference in temperature.

Thermal Equilibrium: The state at which the temperatures of two systems are equal, and heat transfer ceases.

Heat flow continues at contact until thermal equilibrium is reached.



What happens when...?

Two bodies with the same temperature come into contact.

Heat does not flow between them.

Two bodies with different temperatures come into contact.

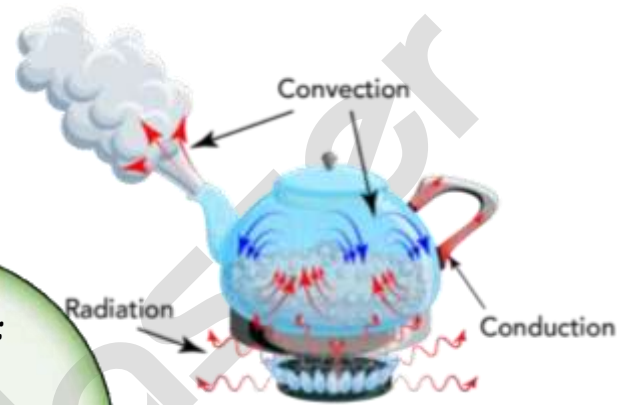
Heat flows from the higher temperature body to the lower temperature body.

Heat transfer methods

Conduction:
occurs
through
some solids.

Convection:
occurs
through
liquid and gas
media.

Radiation:
occurs
through both
material and
non-material
media.



Conduction

Heat is transferred through some solid bodies along the body from one point to another, or from a higher temperature body to a lower temperature body. This method is known as **thermal conduction**.

Heat transfer by conduction The transfer of heat through some solids from a higher temperature end to a lower temperature end.

Example: When we put three spoons of different materials (metal, wood, and plastic) in a cup of boiling water for a minute, and then touch the tip of each spoon, we feel the heat of the metal spoon and we do not feel the heat of the wooden or plastic spoon, as a result of their difference in **thermal conductivity**.



Thermal conductivity

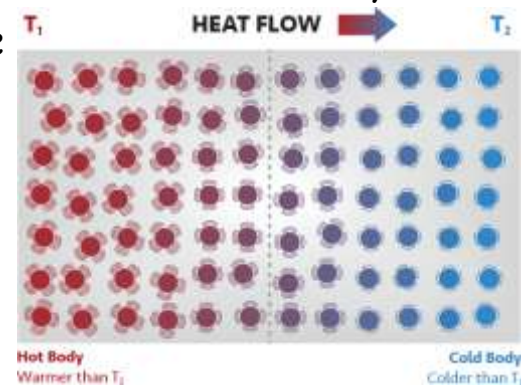
A measure of how well a material conducts heat.

Materials vary in their thermal conductivity and are classified into two types:

Good Thermal Conductors	Poor Thermal Conductors
Materials with high thermal conductivity are called thermal conductors.	Materials with very low thermal conductivity are called thermal insulators.
Such as: metals (iron, copper, aluminum).	Such as: wood, plastic, glass, cork.

Explanation of heat transfer by conduction:

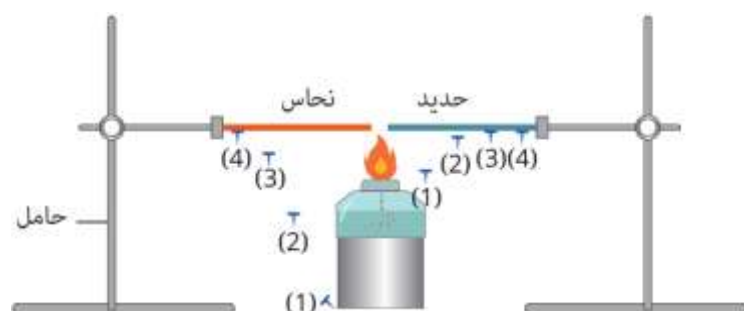
- 1- When the tip of a metal rod is heated, the kinetic energy of the particles within it increases, causing them to vibrate more.
- 2- Some of the energy of these particles is transferred when they collide with neighboring particles, increasing the kinetic energy of the neighboring particles.
- 3- In the same way, some of the energy is transferred to the next particles without the particles themselves shifting their positions.



Metals vary in their degree of thermal conductivity, as in the following experiment:

An activity that demonstrates the differences in the thermal conductivity of metals.

Tools: Two iron and copper rods of the same dimensions - office pins - two easels - candles - a heat source - a stopwatch.



Steps:

- Hang both legs horizontally on the brackets.
- Use wax to secure pins to each leg at equal intervals.
- Place a heat source under each end of the legs.
- Record the time each pin falls in seconds from the moment the flame is lit.

Note: Staples attached to a copper shank fall out **faster than** those attached to an iron shank.

Conclusion: Metals vary in their thermal conductivity, with copper conducting heat **faster than** iron.

Integration with Mineralogy

Natural elements vary in thermal conductivity, with:

Diamond ranks first in thermal conductivity among natural elements, followed by **silver**, then **copper**.



Life Applications

1. Cookware:

Cookware is made from metal due to its high thermal conductivity. **Cookware handles are made from plastic or wood** due to its low thermal conductivity.



2. Insulating Building Walls:

It is preferable to use thermal insulating materials, such as polystyrene panels between hollow bricks when constructing building walls.

This avoids rapid changes in temperature inside buildings when compared to outside temperatures, thus reducing the cost of air conditioning.

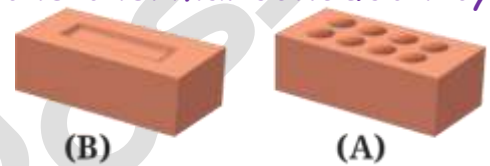


3. Cooling Electronic Devices

Electronic devices, such as computers and smartphones, contain cooling systems that use materials that conduct heat well, such as silver, to dissipate the heat generated in internal components, which could lead to poor performance and damage.



Example: Imagine you're an engineer. Which of the two types of clay bricks shown in the figure below would you prefer to use in building the exterior walls of a building? Given that the thermal conductivity of clay is approximately 20 times higher than that of air, please explain.



The hollow bricks in Figure (A) are used because the air within the voids in hollow bricks is a poor conductor of heat (a good thermal insulator).

Learn more about the economic and environmental impacts of thermal insulation for buildings.

Economic impacts of thermal insulation for buildings.

- Helps save energy consumption.
- Reduces maintenance costs and extends the life of equipment.
- Increases the building's real estate value.

Environmental impacts of thermal insulation for buildings.

- Contributes to reducing greenhouse gas emissions.
- Conserves natural resources.

Heat Transfer by Convection

Any object floating in the air needs something to support it and counteract the force of gravity pulling it downward.



An eagle remains in the air at great heights without flapping its wings thanks to the warm air currents rising from the Earth's surface, known as convection currents.

To understand how heat transfer occurs by convection, let's conduct the following experiment.

Tools: Water - Potassium permanganate - Beaker - Flame.

Steps:

- Place a beaker containing water over a flame.
- Drop a purple crystal of potassium permanganate into the beaker.
- Record your observations during the heating process.



Note: The spread of the purple color of potassium permanganate in water from the bottom to the top.

Explanation: When the water at the bottom of the cup is heated, the water molecules gain thermal energy, moving faster and further apart. This reduces their density and causes them to rise, while the cooler (denser) water sinks to replace them.

The constant movement of the water molecules causes heat to be transferred and distributed throughout the liquid in the form of convection currents, resulting in the purple color spreading up and down in a continuous cycle.

Conclusion: Heat is transferred through liquids and gases by the movement of molecules through convection.

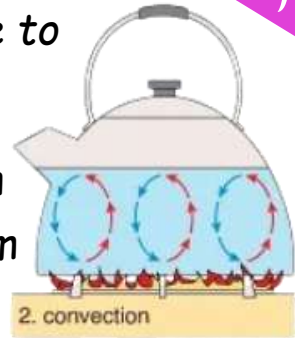
Convection Currents

The vertical movement of particles in liquids and gases due to differences in temperature and density of the medium.

Heat is transferred through liquid and gaseous media from bottom to top by the ascent of hot particles of the medium and the descent of cold particles of the medium.

This method is known as **convection heat transfer**.

Convection Heat Transfer: Heat is transferred through liquid and gaseous media by the ascent of hot particles of the medium (the less dense ones) and the descent of cold particles of the medium (the denser ones) downward.



In Real-Life Applications

1. Placing a heater on the floor of a room:

Heat is transferred from the heater to the air next to it. The warm air rises upward, and the cold air below descends to replace the warm air. This distributes heat throughout the room and warms it.



The heater is placed on the floor of the room.

Heats the air nearby, making it less dense and rising, replaced by denser, cooler air. This continues until all the air in the room is warmed.

2. Sea breeze: A sea breeze is a natural phenomenon that occurs when the land temperature rises **faster than** the water temperature during the day.

It's the movement of cold air from the sea to the land during the day is due to the temperature difference.



The effect of the sea breeze is more pronounced in the summer than in the spring or fall.

Explanation of the Sea Breeze

1- The air in contact with land heats up more than the air above the water's surface when sunlight strikes it.

Because the specific heat of land is lower than the specific heat of water.

2- The density of the air in contact with land decreases and it rises.

3- It is replaced by cooler air from the sea, forming a sea breeze.

Radiation

Heat is transferred by conduction and convection via particles of matter.

In radiation, heat can be transferred through a vacuum and does not require a physical medium.

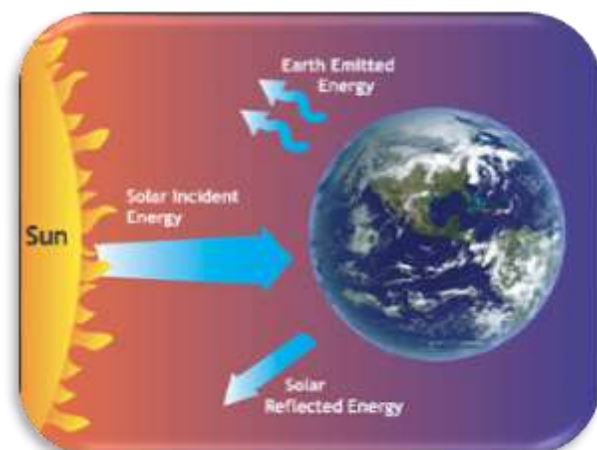
Example: Heat is transferred from the sun to the Earth's surface, even though there are millions of kilometers of space between them.

Radiation Heat Transfer: A method by which heat is transferred through a vacuum without the need for a physical medium.

Heat is transferred by radiation through both **physical and non-physical media**.

Solar Radiation

Solar radiation consists of many **electromagnetic waves** that propagate through space at a very high speed, reaching **300,000 Km/s** in all directions.



Electromagnetic waves are divided into:

- Visible waves, *such as light.*
- Invisible waves, *such as infrared radiation, which has a thermal effect. When materials absorb infrared radiation, their temperature rises, which is why you feel warm when exposed to solar radiation.*

Hot objects are a source of infrared radiation.

Opaque (dark) objects absorb infrared radiation better than bright objects; therefore:

Firefighters wear shiny silver clothing.

Because they reflect the maximum amount of heat and thermal radiation from the fire.



Solar water heater tubes are painted black.

Because the black color absorbs the maximum amount of heat energy from the sun's rays, the water heats up faster.



It's best to wear opaque clothing in the winter

because it absorbs infrared radiation better, making us feel warmer.

Technological Applications

Hot objects are a source of infrared radiation, which helps us photograph objects in the dark using a thermograph.

The thermograph: *A camera can detect the thermal radiation emitted by objects (infrared radiation) and convert it into color images.*



The colors of the images depend on changes in the object's temperature.

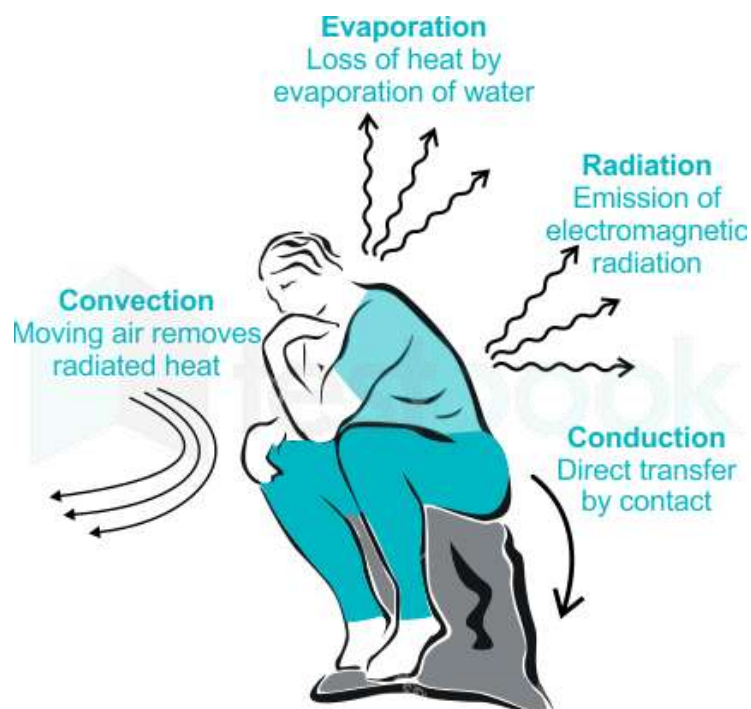
Importance: These cameras are used for:

1. Photographing in the dark.
2. Detecting the temperature of objects.

Integration with Biology

Snakes are able to hunt their prey at night.

This is because they have **sensory receptors** in the front of their heads that enable them to detect infrared radiation emitted by their prey's bodies.



Questions

Write the scientific term:

- (1) Energy transferred from one system to another due to a difference in their temperatures. (.....)
- (2) The state reached by two systems of different temperatures after contact, when their temperatures are equal. (.....)
- (3) The transfer of thermal energy through solids without the movement of their particles. (.....)
- (4) A measure of the ability of materials to conduct heat. (.....)
- (5) The transfer of thermal energy in fluids with the movement of their particles. (.....)
- (6) The movement of cold air from the sea during the day toward land. (.....)
- (7) Waves that propagate in a vacuum in all directions at a speed of 300,000 km/s. (.....)
- (8) The transmission of infrared radiation from the surfaces of hot objects without the need for physical particles. (.....)
- (9) A technique that uses a camera to sense the thermal radiation emitted by objects & convert it into color images. (.....)

Correct the underlined:

- (1) Heat is a form of matter. (.....)
- (2) Heat is transferred through solids from one end to the other by convection. (.....)
- (3) When two identical copper cubes, the temperature of one being 60°C and the temperature of the other being 400°C, come into contact, their temperature at thermal equilibrium becomes 200°C. (.....)
- (4) Copper ranks first in thermal conductivity among natural elements. (.....)
- (5) When heat is transferred by radiation, hot water particles rise upwards and cold water particles sink downwards. (.....)
- (6) The effect of the sea breeze phenomenon is more pronounced in the spring. (.....)
- (7) Infrared radiation has a chemical effect. (.....)

(8) The idea of wearing clothing in the winter is based on heat transfer by conduction. (.....)

(9) When we stand in front of a light bulb, heat is transferred to us by conduction. (.....)

Put (✓) or (X):

(1) The transfer of thermal energy from one system to another depends on a temperature difference between them. ()

(2) Heat is transferred from a colder body to a hotter body. ()

(3) A spoon becomes cold after being used to stir iced water in a cup because the spoon loses heat to the iced water. ()

(4) When a cube of metal at 60°C is dropped into a tub of water at 90°C , the temperature of the water does not change. ()

(5) When stirring a cup of hot tea with a metal spoon, heat is transferred to the hand by radiation. ()

(6) Thermal equilibrium occurs when there is a difference in the amount of heat. ()

(7) Metals are thermally conductive materials. ()

(8) Copper has a greater thermal conductivity than silver. ()

(9) Solid bricks have better thermal conductivity than hollow bricks. ()

(10) The heat generated in smartphone components leads to poor performance. ()

(11) Heat is transferred through solids and liquids by convection. ()

(12) When air cools, its density decreases and it sinks. ()

(13) An electric heater is placed on the floor of a room to heat the air by conduction. ()

What is meant by each of the following:

(1) Heat.

(2) Thermal equilibrium.

(3) Thermal conductivity.

(4) Thermal conductivity

(5) Convection.

(6) Sea breeze.

(7) Radiation.

(8) Electromagnetic waves

Give Reason for:

(1) The temperature of a cold solid object rises when it comes into contact with a hot piece of iron.
.....

(2) The temperature of a hot piece of metal decreases when placed in a cup of cold water.
.....

Matter & Chemical Reactions

L1: Chemical Reactions

Chemical Reaction

We previously learned that matter undergoes various types of changes that affect it in multiple ways. These changes are divided into two types: *Physical changes and chemical changes*.

A comparison can be made between a physical change and a chemical change, as shown in the following table.

Physical Change	Chemical Change
A change in the state or form of matter without a change in its chemical composition.	A change that produces new substances with different chemical properties from the original substances.
Melting ice - Dissolving salt in water - Cutting tomatoes	Wood burning - Fruit rot Iron rust
	

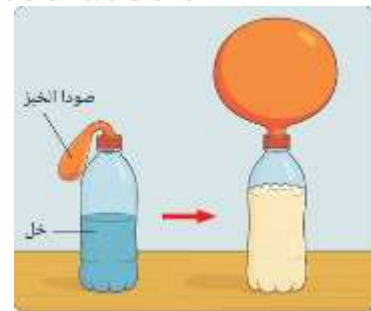
A chemical change occurs when original substances react chemically with other substances to form new compounds.

The concept of chemical reaction

Tools: Baking soda (sodium bicarbonate) - Vinegar (diluted acetic acid) - Balloon - Empty bottle - Spoon.

Steps

1. Put two tablespoons of baking soda into the balloon.
2. Put a quantity of vinegar into the bottle.
3. Tightly secure the balloon's opening to the bottle's mouth, being careful not to spill any of the baking soda into the balloon.
4. Lift the balloon and let the baking soda fall into the solution in the bottle.



Note: Fizzing and gas will occur.

The balloon will gradually begin to inflate due to the gas produced by the reaction.



Conclusion: A chemical reaction between baking soda (sodium bicarbonate) and vinegar (dilute acetic acid) resulted in fizzing and the release of carbon dioxide gas (a new substance). Therefore, this change is considered a chemical change.

Chemical Reaction: The process of breaking the bonds between the atoms of the molecules of the reactants and forming new bonds between the atoms of the molecules of the substances resulting from the reaction.

A chemical reaction occurs when reactants combine, dissociate, or replace each other to form new products.

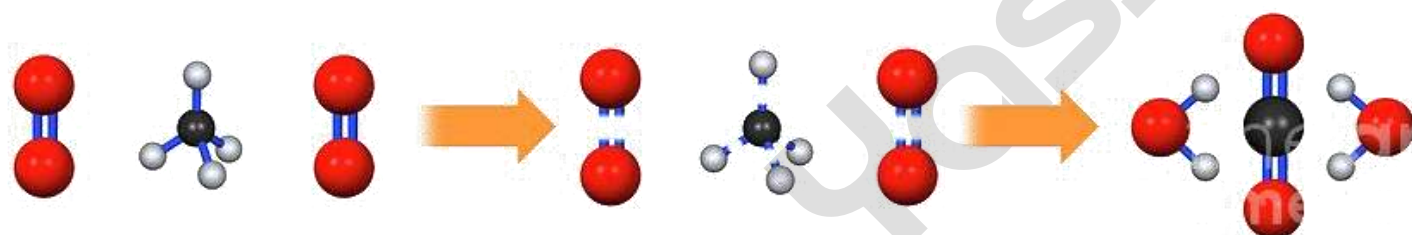
Steps of a chemical reaction:

1. Breaking the bonds between the atoms of the reactant molecules.
2. Rearranging the atoms and combining them with new bonds to form new substances with different properties from the original substances.



Example:

The combustion of methane gas (CH_4) in the presence of oxygen gas (O_2):



Reactants before the reaction occurs.

Breaking the bonds between the atoms of the reactant molecules.

Formation of new bonds between the atoms of the product molecules.

In the previous reaction, bonds between the atoms of methane gas molecules and also between the atoms of oxygen gas molecules broke. The atoms rearranged and combined with chemical bonds to form new compounds: carbon dioxide (CO_2) and water vapor (H_2O).

- The color change of a universal indicator strip when exposed to ammonia gas is considered a chemical change.

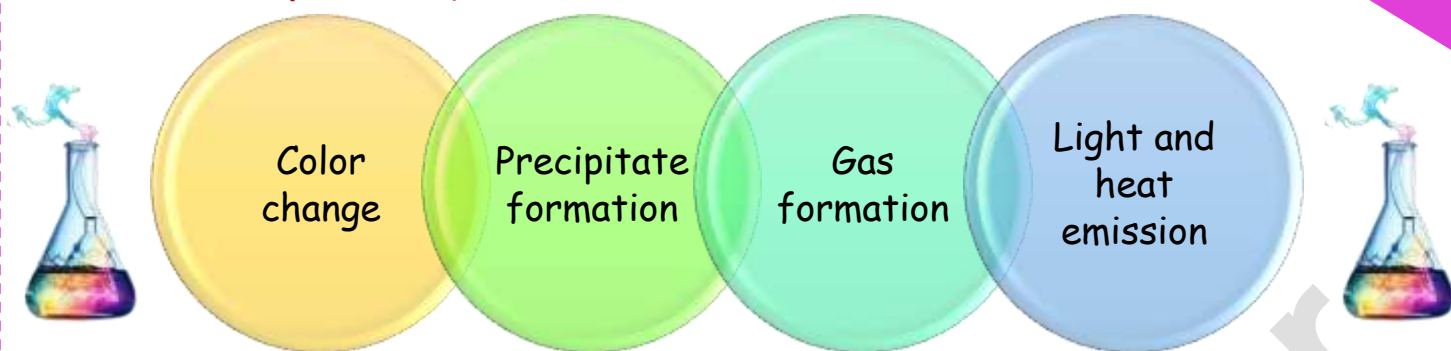
A chemical reaction occurs between the indicator material and the ammonia gas, resulting in the formation of a new substance with a different color.

- The clouding of limewater when carbon dioxide gas is passed through it is considered a chemical change.

A chemical reaction occurs between the gas and the limewater solution, resulting in the formation of a new substance that is insoluble in water.



Indicators of a chemical reaction

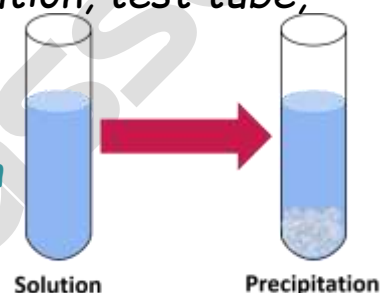


Precipitate formation activity

Tools: Sodium chloride solution, silver nitrate solution, test tube, dropper.

Steps:

1. Place a small amount of sodium chloride solution in the test tube.
2. Add drops of silver nitrate solution.



Note: A reaction occurs and a white precipitate is formed.

Conclusion: A chemical reaction occurs when silver nitrate (AgNO_3) solution is added to sodium chloride (NaCl) solution, resulting in the formation of a white precipitate of silver chloride (AgCl), which is insoluble in water and changes color to purple in sunlight.

Activity: Color Change

Tools: Glass beaker, zinc plate, copper sulfate solution.

Steps

Put the copper sulfate solution into the beaker.
Place the zinc plate in the solution.

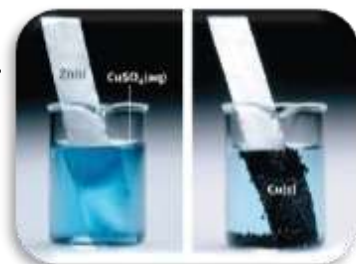
Note: The blue color of the copper sulfate solution disappears and a reddish brown color appears on the zinc plate.

Conclusion

The chemical reaction between the zinc (Zn) plate and the copper sulfate (CuSO_4) solution is indicated by:

The blue color of the copper sulfate solution disappears, leaving the zinc sulfate (ZnSO_4) solution colorless.

Reddish-brown copper deposits on zinc plate



Gas formation activity

Tools: Magnesium strip - dilute hydrochloric acid - test tube.

Steps:

Place the magnesium strip in a test tube.

Add dilute hydrochloric acid to it.

Note: Reaction and the formation of gas bubbles.

Conclusion: A chemical reaction is indicated when dilute hydrochloric acid (HCl) is added to magnesium (Mg) by the formation of gas bubbles from the evolution of hydrogen gas (H_2).



Activity: Emission of light

Tools: Magnesium strip - water - mask - flame.

Steps

Hold the end of the magnesium strip with the holder.

Ignite the end of the strip with a flame.

Dip the resulting powder into the water.



Note: A reaction occurs, and the magnesium ribbon glows with a dazzling light, accompanied by the emission of heat.

The resulting white powder dissolves in water.

Conclusion

A chemical reaction is indicated when a magnesium (Mg) ribbon is ignited by the ribbon glowing brightly, accompanied by the emission of heat. The magnesium ribbon is transformed into a white powder of magnesium oxide (MgO), which dissolves in water.



EXAMPLE

Copper chloride solution reacts with sodium hydroxide solution, forming sodium chloride solution and copper hydroxide, which is insoluble in water. **How can this chemical reaction be determined?**

A chemical reaction is determined by the formation of a blue precipitate of copper hydroxide, which is insoluble in water.



Sodium hydroxide solution (NaOH) is added to both copper sulfate and ferrous sulfate solutions. *How can we distinguish between them, despite the formation of a precipitate in both cases?*

Because the color of the precipitate is different in both cases, with copper sulfate, a blue precipitate of copper hydroxide is formed, while with ferrous sulfate, a green precipitate of ferrous hydroxide is formed.

The rotting of an orange indicates a chemical reaction. *How can this reaction be determined?*

A chemical reaction is determined by the change in the color of the orange to a dark green color and the emanation of an odor from the rotting part.

When sulfuric acid reacts with baking soda (sodium bicarbonate), effervescence occurs and carbon dioxide gas is released. *How can this reaction be determined?*

This reaction can be determined by the effervescence and release of carbon dioxide gas.

Cause

Effect

A chemical reaction occurs.

Leads to the formation of a precipitate, color change, gas evolution, light and heat emission, extinguishing a burning match, or increasing the glow of a burning splinter.



Laboratory Safety Precautions:

Laboratory safety precautions are essential to protect everyone from hazards and ensure a safe and orderly work environment. These include:

1. Use a protective mask to avoid the harmful effects of bright light.

2. Avoid touching the white powder formed immediately after the magnesium ribbon ignites in the air, as it will be hot immediately after the reaction.
3. Hold the magnesium ribbon with a heat mask to avoid burns during ignition.
4. Handle acids, especially concentrated ones, with extreme care.

Properties of materials before and after a chemical reaction

The properties of materials **change** after a **chemical reaction** occurs, as the original materials are transformed into **new materials** that differ in color, shape, or other properties.

To learn about the differences in the properties of materials before and after a chemical reaction.

Activity 1: Burning Sugar

Tools: Table sugar, spoon, flame

Steps:

Put a spoonful of table sugar.

Slowly heat the sugar by holding the spoon over a flame.

Observe and record the changes that occur.

Note

The sugar turns into a brown molten substance and begins to burn.
A strong, caramel-like odor is produced.



Conclusion

When molten sugar burns, a chemical reaction occurs, as evidenced by: A strong odor (caramel smell) - Smoke - Color change - Formation of a new substance (carbon)

Activity 2: The Reaction of Oil with Caustic Soda

Tool: Oil, glass beaker, caustic soda solution (sodium hydroxide), flame, stirring rod

Steps:

Place 100 ml of vegetable oil in a 250 ml glass beaker.
Add 30 ml of caustic soda solution (sodium hydroxide) to the oil, drop by drop.

Heat the mixture using a suitable heat source at 40-50°C, stirring the ingredients well in one direction.
Observe and record the changes that occur.



Note: The consistency of the mixture changes and a new substance is formed as a result of a chemical reaction.

Conclusion: Adding oil to a caustic soda solution and heating it leads to a chemical reaction, evidenced by a change in consistency, and the formation of a new substance (soap).

We conclude from the previous activities that the properties of materials change when a chemical reaction occurs, as shown in the following table.:

Burning sugar	Reacting oil with caustic soda
Properties of substances before reaction	
Sugar is white. Solid. Soluble in water.	Oil is a liquid (fatty) that does not dissolve in water. Caustic soda is a solid that dissolves in water.
Properties of materials after reaction	
A new, solid, brown substance is formed, which then turns black. It does not dissolve in water. It emits a caramel odor.	A new, sticky substance is formed. Soluble to a certain degree in water, forming a foam.
a chemical reaction occurred.	

Evidence of a chemical reaction.

A strong odor (caramel smell) appears.

Color change.

Smoke.

Formation of a new substance (carbon).

Change in texture.

Formation of a new substance (soap).

Chemical Reactions in Life

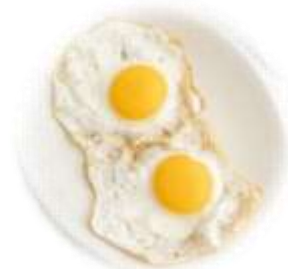
Chemical reactions are an integral part of our daily lives. They occur everywhere around us, from cooking food and breathing to cleaning the house and celebrating with fireworks.

Examples of chemical reactions in our daily lives:

1. Cooking Food

Example: When frying eggs, a chemical reaction occurs.

Evidence of a chemical reaction: A **change in the color and texture** of both the white and yolk.



2. Fruit color change

Example: When you cut an apple, a chemical reaction occurs with the oxygen in the air.

Evidence of a chemical reaction: The apple turns brown.



3. Iron rust

When iron is exposed to oxygen in moist air, a chemical reaction occurs, causing the iron to rust.

Evidence of a chemical reaction: a change in the color of the iron.



4. Fireworks

When fireworks ignite, a chemical reaction occurs.

Evidence of a chemical reaction is the emission of **light and heat**.



Questions

Write the scientific term:

- (1) A change in the state or form of a substance without changing its chemical composition. (.....)
- (2) A change that produces new substances with properties different from those of the original substances. (.....)
- (3) A gas produced by the reaction of sodium bicarbonate with dilute acetic acid. (.....)
- (4) The breaking of bonds between the atoms of the molecules of the reactants and the formation of new bonds between the atoms of the molecules of the products. (.....)
- (5) A white precipitate that turns purple when exposed to sunlight. (.....)
- (6) A solid substance produced by the reaction of oil with a caustic soda solution. (.....)
- (7) The color of iron changes when exposed to oxygen in the humid atmosphere. (.....)

Correct the underlined:

- (1) A chemical reaction between sulfuric acid and sodium bicarbonate is indicated by the formation of a precipitate. (.....)
- (2) When silver nitrate solution is added to sodium chloride solution, a white precipitate of sodium nitrate is formed. (.....)
- (3) When magnesium oxide is exposed to sunlight, it turns purple. (.....)
- (4) Copper sulfate solution is colorless. (.....)
- (5) The scientific name for caustic soda is sodium bicarbonate. (.....)
- (6) Copper rusts when exposed to oxygen in moist air. (.....)

Put (✓) or (X):

- (1) Physical changes do not alter the chemical composition of the substance. ()
- (2) Melting wax produces a new substance. ()
- (3) Chemical changes produce new substances with properties different from those of the original substances. ()
- (4) The transformation of milk into butter is a physical change. ()
- (5) The odors associated with cooking food are evidence of physical changes. ()

(6) A change in color and texture over time indicates a chemical reaction. ()

(7) All chemical reactions are accompanied by the formation of bonds between the atoms of the reactant molecules. ()

(8) Magnesium oxide powder is white and insoluble in water. ()

(9) Burning sugar changes its physical properties. ()

What is meant by each of the following:

(1) Physical change.

(2) Chemical change.

(3) Chemical reaction

Give Reason for:

(1) The melting of ice is a physical change.

(2) The burning of wood is a chemical change.

(3) The shattering of a tightly sealed, filled water bottle when placed in a refrigerator is not a chemical reaction.

(4) Chemical reactions are accompanied by the formation of new substances.

(5) Effervescence occurs when sodium bicarbonate is added to acetic acid.

(6) A white precipitate is formed when silver nitrate solution is added to sodium chloride solution.

(7) The reaction of zinc with copper sulfate solution is indicated by the color change.

(8) Gas bubbles form when dilute hydrochloric acid is added to a magnesium ribbon.

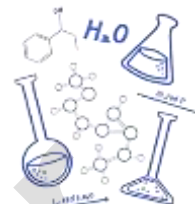
(9) When burning a magnesium ribbon, a protective mask must be used.

(10) The white powder formed immediately after burning a magnesium ribbon should not be touched.

(11) The rotting of an orange when left for a long time is an indication of a chemical reaction.

L 2: Chemical Equation

The Symbolic Chemical Equation



When a chemical reaction occurs, it is expressed using a **symbolic chemical equation** that shows the reactants and products using molecular symbols and formulas.

It is not preferable to express chemical reactions using a word equation.

- This is because the word equation does not express the number of molecules or atoms present in the reaction mixture.

The Symbolic Chemical Equation

A symbolic representation of a chemical reaction that shows the reactants and products using molecular symbols and formulas, showing the simplest ratio of the number of molecules or atoms involved in the reaction to the number resulting from it.

EXAMPLES

1. The combustion of carbon in the presence of oxygen gas to form carbon dioxide gas.

The word equation: Carbon + Oxygen $\xrightarrow{\text{Heat}}$ Carbon Dioxide.

The word equation for this reaction does not specify the number of molecules or atoms involved in and resulting from the reaction; therefore, it is expressed as a **symbolic chemical equation**.

Steps for writing a symbolic chemical equation:

1. Write the symbols and formulas of the **reactants** on the **left side** of the equation.
2. Write the symbols and formulas of the **products** on the **right side** of the equation.
3. Connect the reactants and products with an arrow indicating the **direction of the reaction**. The reaction conditions, if any, are written above the arrow.

Examples of chemical reaction conditions written above the arrow:

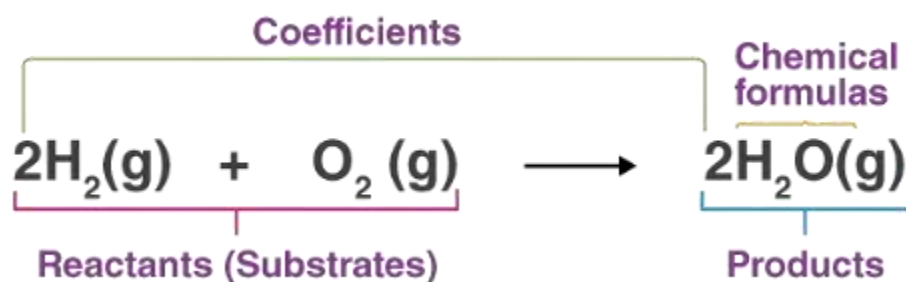
Symbol	Δ	cat	dil	conc
Meaning	Heat	Use of catalyst	Use of dilute acid	Use of concentrated acid

Catalysts: Substances that change the rate of a chemical reaction without being consumed or changed.

The **physical states** of the reactants and products are represented by **symbols or abbreviations** placed in parentheses slightly to the right of the symbol below, as shown in the following table.

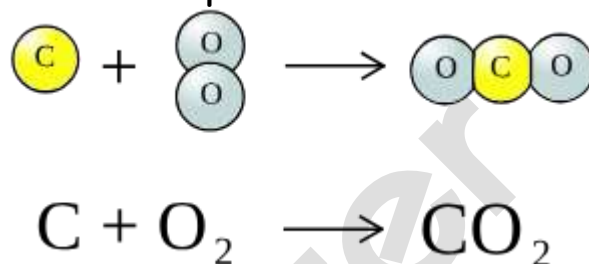
Symbol	(s)	(l)	(g)	(v)	(aq)
Physical State	Solid or precipitate that does not dissolve in water	Liquid	gas	vapor	aqueous solution (solute)

EXAMPLE

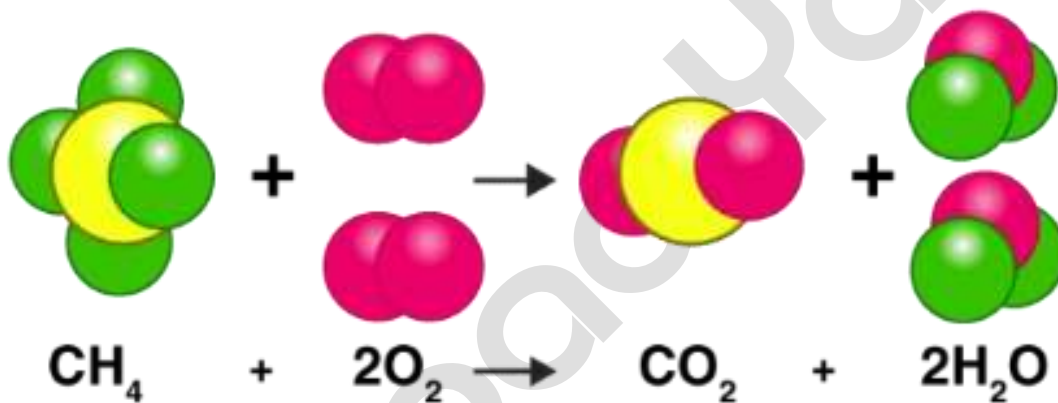


We learned previously that carbon is a **solid** non-metal, and oxygen and carbon dioxide are **gases**. Therefore, we can write the **chemical equation** for the combustion of carbon in the atmosphere as follows:

C	O₂	CO₂
1 atom	2 atom	1 atom C + 2 atom O ₂



Combustion of methane gas (CH₄) in the presence of oxygen gas to form water vapor and carbon dioxide gas.



CH₄	2O₂	CO₂	2H₂O
1 atom C + 4 atoms H ₂	4 atoms	1 atom C + 2 atom O ₂	4 atoms H ₂ +2 atom O ₂

Law of conservation of mass

Experiments have proven that there is a relationship between the substances that enter into a chemical reaction and the substances that result from it, and that they are subject to special laws known as the laws of chemical combination, including the law of conservation of mass (the law of conservation of matter).



To learn about the law of conservation of mass (the law of conservation of matter), we will conduct the following activity.

Law of Conservation of Mass Activity

Tools: Calcium chloride solution, sodium sulfate solution, test tube, beaker, sensitive balance, stopper

Steps

Place a quantity of calcium chloride solution in a test tube and a quantity of sodium sulfate in a beaker.

Place the test tube in the beaker carefully to prevent the two solutions from mixing.

Cover the mouth of the beaker with the stopper.

Find the mass of the beaker with the test tube inside.

Invert the beaker to cause a reaction between the two solutions.

Re-find the mass after the reaction.

Compare the mass before and after the reaction.



Note: The mass before the reaction equals the mass after the reaction.

Conclusion: The mass of the reactants did not change despite the chemical reaction accompanied by the formation of a calcium sulfate precipitate. We conclude from this that the total mass of the reactants in the reaction equals the total mass of the products, which is called the law of conservation of mass.

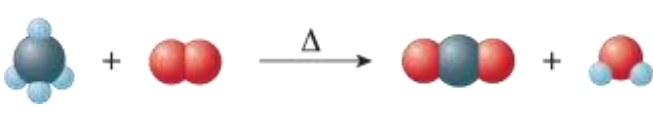
Law of conservation of mass

The total mass of the reactants in a reaction equals the total mass of the products in the reaction.



The law of conservation of mass is illustrated by the following example:

When methane gas CH_4 is burned in the presence of oxygen gas to form carbon dioxide gas CO_2 and water vapor H_2O , which is expressed in the following two forms:

Figure (1)				Figure (2)			
							
element	No. of atoms in the reactants	No. of atoms in the products	weight	element	No. of atoms in the reactants	No. of atoms in the products	weight
C	1	1	✓	C	1	1	✓
H	4	2	✗	H	4	4	✓
O	2	3	✗	O	4	4	✓
From Figure (1), we find that: The number of carbon atoms in the reactants equals the number of carbon atoms in the products. The number of hydrogen atoms in the reactants is greater than in the products (unequal). The number of oxygen atoms in the reactants is less than in the products (unequal). Therefore, the total masses of the reactants do not equal the total masses of the products. Therefore, this equation is unbalanced and does not satisfy the law of conservation of mass.				From Figure (2), we find that: The number of carbon atoms in the reactants equals the number of carbon atoms in the products. The number of hydrogen atoms in the reactants equals the number of hydrogen atoms in the products. The number of oxygen atoms in the reactants equals the number of oxygen atoms in the products. Therefore, the total masses of the reactants in the reaction equal the total masses of the products. Therefore, this equation is balanced and satisfies the law of conservation of mass.			

We conclude from the previous example that:

When a chemical reaction occurs, the reactants are **not destroyed**, nor are new substances **created from nothing**. Rather, the atoms of the reactants are rearranged to form new products with the same number of atoms of each element, which fulfills the **law of conservation of matter**.

Balanced Chemical Equation

A balanced chemical equation is described as balanced when the number of atoms of each element in the reactants is equal to the number of atoms of the same element in the products.

Balanced Chemical Equation

A balanced chemical equation is a chemical equation in which the number of atoms of each element in the reactants is equal to the number of atoms of the same element in the products.

Before learning how to balance a symbolic chemical equation, we need to understand some terms.

Subscripts

Numbers below the symbols of the elements that make up a molecule, representing their number in a single molecule.

Constant numbers that do not change when balancing the equation.

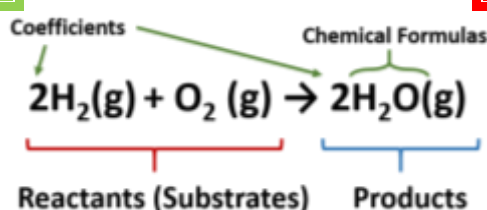
Coefficient



Subscripts

Coefficients

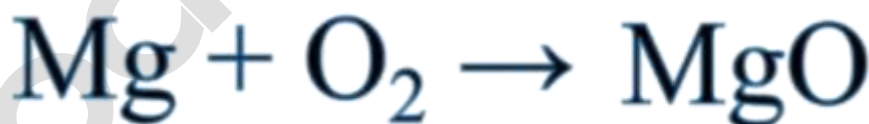
Numbers preceding the molecular formulas of compounds or the symbols of elements. They can be modified when balancing the equation.



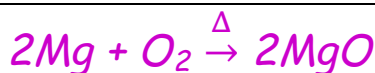
Steps for Balancing a Symbolic Chemical Equation

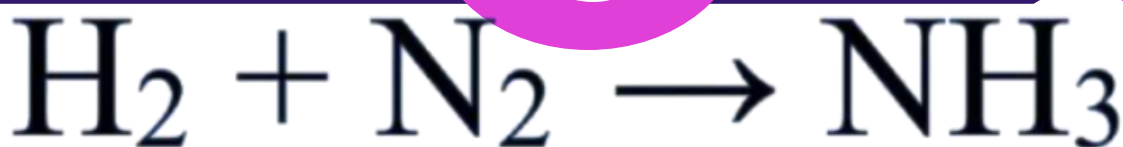
1. Write the **correct molecular formulas** for both the reactants and products in the form of a symbolic equation.
2. Calculate the number of atoms for each element in the reactants and products.
3. If the number of atoms is not equal, adjust one of the coefficients preceding the molecular formulas of the compounds or the symbols of the elements and recalculate the number of atoms.
4. If the coefficient is repeated, adjust the coefficients, even more than once, taking care not to write the coefficient if it is equal to 1 and not to alter the subscripts.
5. **Verify the balance of the chemical equation** by ensuring the number of atoms for each element on both sides of the equation is equal, ensuring that the ratio between the coefficients of the balanced chemical equation is as simple as possible.

EXAMPLE



$\text{Mg} + \text{O}_2 \xrightarrow{\Delta} \text{MgO}$	element	No. of atoms in the reactants	No. of atoms in the products	balance	Calculate the number of atoms of each element in the reactants and products.
	Mg	1	1	✓	
	O	2	1	✗	
$\text{Mg} + \text{O}_2 \xrightarrow{\Delta} 2\text{MgO}$	element	No. of atoms in the reactants	No. of atoms in the products	balance	The coefficient of magnesium oxide is changed to 2 to equalize the number of oxygen atoms and we recalculate the number of atoms.
	Mg	1	2	✗	
	O	2	2	✓	
$2\text{Mg} + \text{O}_2 \xrightarrow{\Delta} 2\text{MgO}$	element	No. of atoms in the reactants	No. of atoms in the products	balance	We change the magnesium coefficient to 2 to equalize the number of magnesium atoms, recalculate the number of atoms, and check the balance of the equation.
	Mg	2	2	✓	
	O	2	2	✓	





$N_2 + H_2 \rightarrow NH_3$	element	No. of atoms in the reactants	No. of atoms in the products	balance	Calculate the number of atoms of each element in the reactants and products.
	Mg	2	1	×	
	O	2	3	×	

$N_2 + H_2 \rightarrow 2NH_3$	element	No. of atoms in the reactants	No. of atoms in the products	balance	The ammonia coefficient is changed to 2, the number of nitrogen atoms is equal, and the number of atoms is recalculated.
	Mg	2	2	✓	
	O	2	6	×	

$N_2 + 3H_2 \rightarrow 2NH_3$	element	No. of atoms in the reactants	No. of atoms in the products	balance	We change the hydrogen coefficient to 3, equalizing the number of hydrogen atoms, recalculating the number of atoms, and checking the balance of the equation.
	Mg	2	2	✓	
	O	6	6	✓	

$N_2 + 3H_2 \rightarrow 2NH_3$

Let's balance this unbalanced chemical reaction:



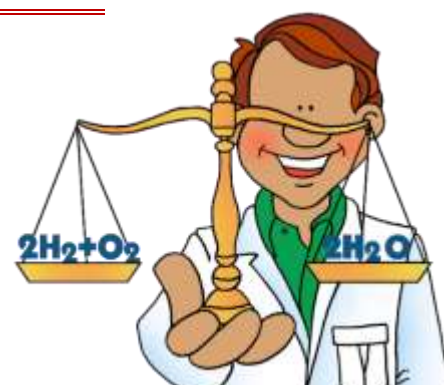
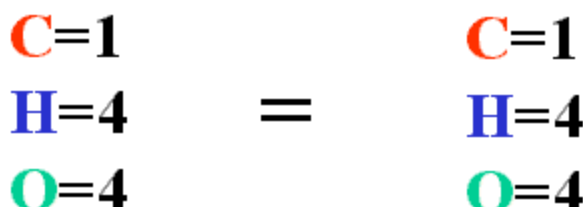
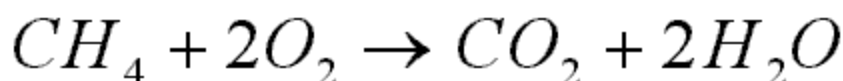
Step 1 (Balancing Carbon atoms)

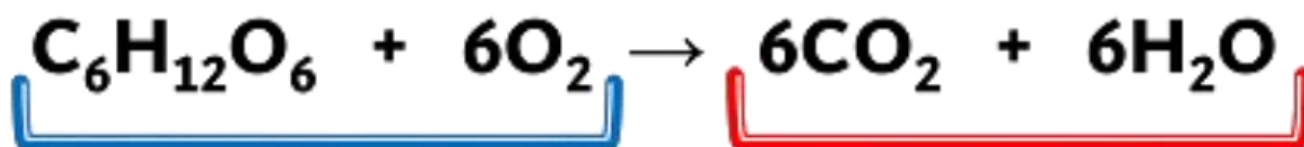


Step 2 (Balancing Hydrogen atoms)



Step 3 (Balancing Oxygen atoms)





6 Carbon atoms
12 Hydrogen atoms
18 Oxygen atoms

6 Carbon atoms
12 Hydrogen atoms
18 Oxygen atoms



About the scientist: Antoine Lavoisier

A French chemist, philosopher, economist, and biologist, he was the first to formulate the law of conservation of mass.

He was also the first to prove that oxygen is an essential substance in combustion, and he gave it this name. He developed the modern system for naming chemical substances and was called the

"Father of Chemistry" for his emphasis on precise experimentation.



Systems and Models

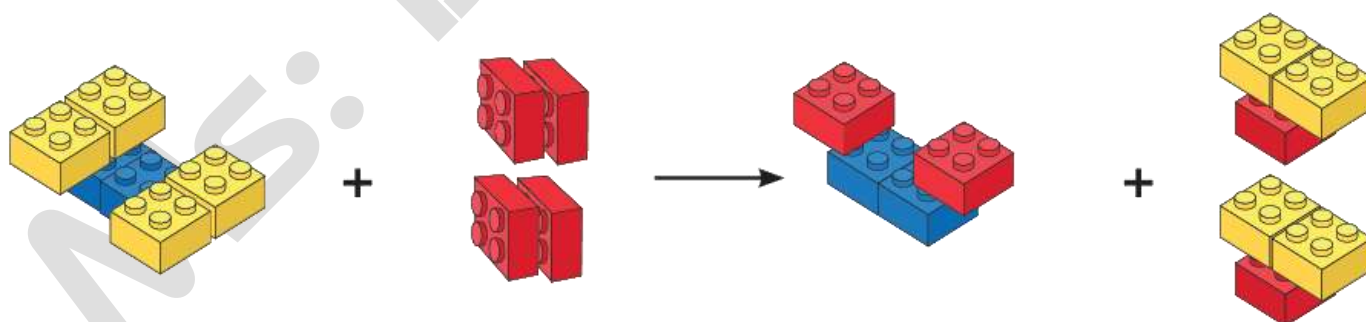
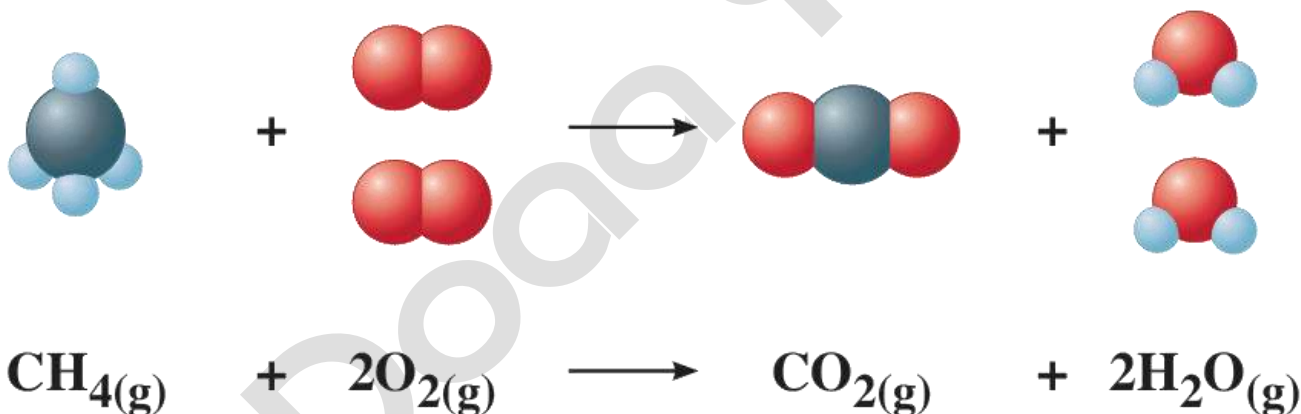
A chemical equation is a symbolic model of what happens during a chemical reaction. It represents a mental representation of what happens at the molecular or atomic level, levels that cannot be seen with the naked eye.

You can use open-source software to automatically balance chemical equations, such as: *PhET Simulation*.

Design molecular-level models of some molecules

Collaborate with your colleagues to design molecular-level models of some molecules and chemical reactions using LEGO bricks.

Example: Design a model of the combustion of methane in oxygen.



Questions

Write the scientific term:

- (1) A symbolic representation of a chemical reaction using symbols and molecular formulas that shows the simplest ratio between the numbers of atoms or molecules of the reactants and the products. (.....)
- (2) A substance that increases the rate of a reaction without being consumed or changed. (.....)
- (3) The law that states that matter can neither be created nor destroyed, but rather is transformed from one form to another. (.....)
- (4) The scientist who formulated the law of conservation of mass. (.....)
- (5) The law that states that the total mass of the substances involved in a chemical reaction equals the total mass of the products. (.....)
- (6) A symbolic chemical equation in which the number of atoms of each element in the reactants is equal to the number of atoms of the same element in the products. (.....)
- (7) The numbers preceding the symbols of elements or the molecular formulas of compounds in a balanced symbolic equation. (.....)
- (8) The numbers below the symbols of the elements that make up a molecule and represent the number of atoms in a single molecule. (.....)

Put (✓) or (X):

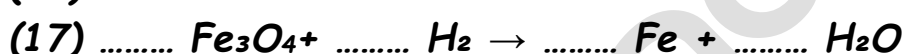
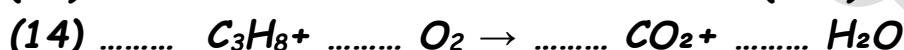
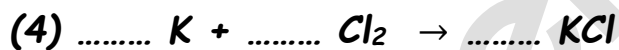
- (1) In a chemical reaction, the atoms of the reactants are rearranged to form new products with the same number of atoms of each element. ()
- (2) In a chemical equation, a cross $\rightarrow$ is placed between each pair of reactants. ()
- (3) In a symbolic chemical equation, the abbreviation (g) indicates the substance that is present in the solid state. ()
- (4) In the equation for the reaction of magnesium with dilute hydrochloric acid, the abbreviation "cat" is placed on the reaction arrow. ()

(5) A chemical equation must be balanced to satisfy the law of conservation of energy. ()

(6) The scientist Robert Brown was called the Father of Chemistry. ()

(7) The mass of a molecule of CO_2 is greater than the mass of a molecule of CO . ()

Rewrite the following chemical equations after balancing them.



What is meant by each of the following:

(1) Symbolic equation.

(3) Balanced symbolic equation.

(2) Catalyst

(5) Law of conservation of matter.

(4) Law of conservation of mass.

(6) Subscripts in an equation

Give Reason for:

(1) The chemical equation must be balanced.

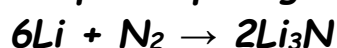
(2) It is preferable to express the chemical reaction using a balanced symbol equation rather than a word equation.

(3) The mass of the reactants must be equal to the mass of the products.

State the number that represents each of the following:

(1) The number of oxygen atoms in a carbon dioxide molecule.

(2) The number of nitrogen atoms participating in the reaction:



L3: Nutritional Chemistry

Carbohydrates



The human body is like a large factory that requires raw materials and energy to function properly. The body obtains these materials and energy from the food we eat, but not all foods perform the same function.

There are foods that serve as a source of energy, others that help absorb certain vitamins, and others that increase muscle strength. We will learn about these foods by studying nutritional chemistry.

Nutritional chemistry

A branch of chemistry that specializes in the study of the types of nutrients in diets, including carbohydrates, fats, and proteins.

First: Carbohydrates

Carbohydrates are an example of nutrients found in diets.

Carbohydrates:

Organic chemical compounds containing carbon, hydrogen, and oxygen.

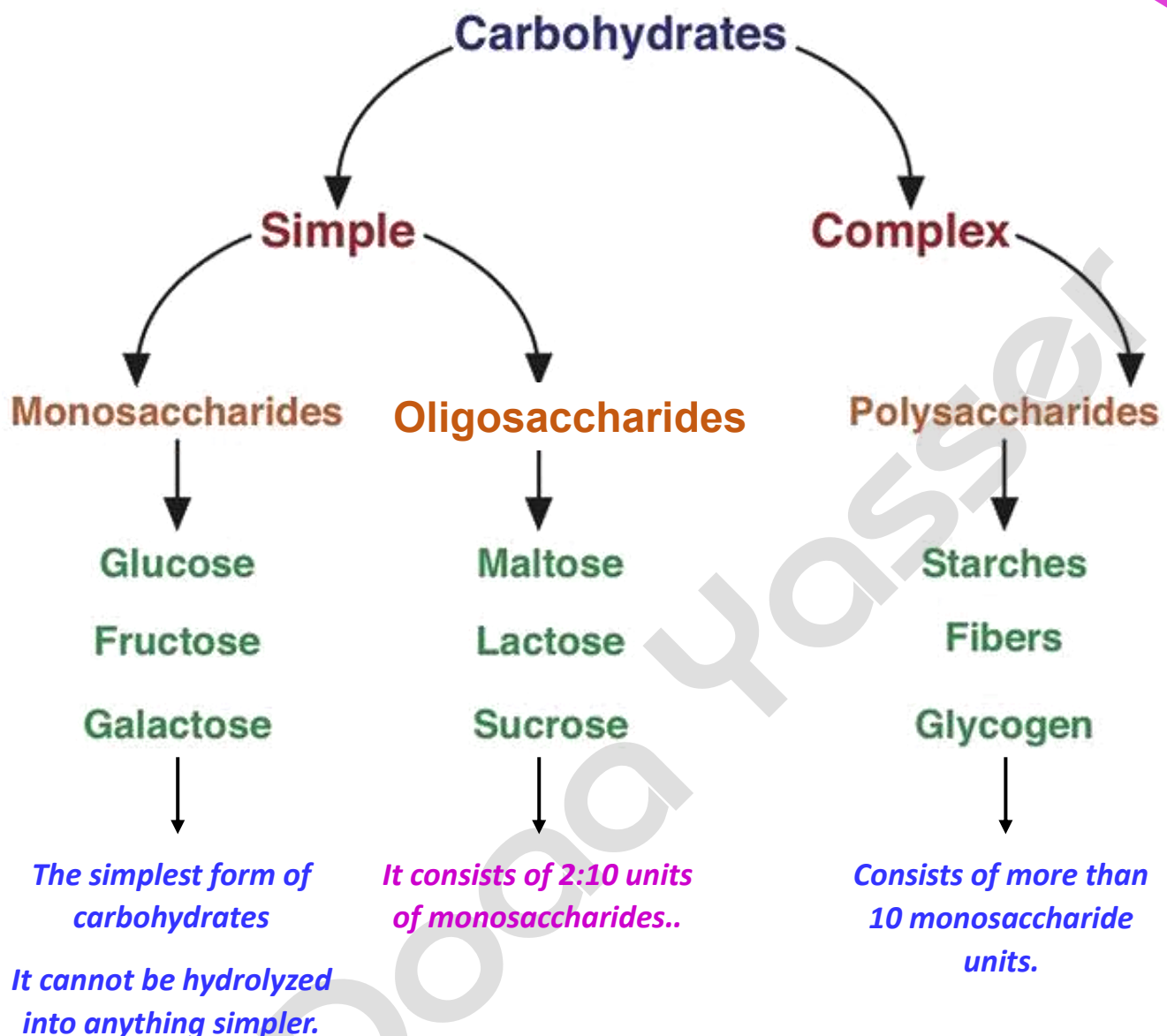
The most important sources of carbohydrates:

Bread. Potatoes. Rice. Grains & vegetables.

Some types of fruit, such as grapes and apples.

Carbohydrates are the reason for the sweet taste of many foods, such as fruits.



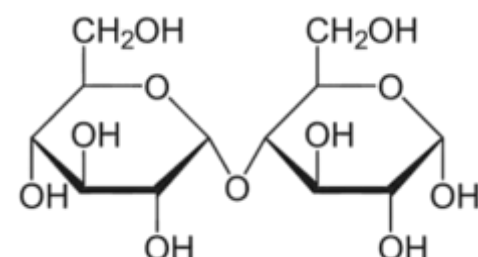


Disaccharides :

Disaccharides are oligosaccharides, an example of limiting sugars, each molecule consists of **two monosaccharide** units with a water molecule removed.

Examples of disaccharides include:

- Sucrose (cane sugar): Consists of one glucose unit and one fructose unit.
- Maltose (barley sugar): Consists of two glucose units.



Glucose detection activity

Tools: Glucose solutions of different concentrations - Test tubes - Benedict's blue solution - Hot water bath

Steps: Place 2 ml of glucose solutions of varying concentrations into test tubes.

Add 2 ml of Benedict's blue solution to each tube.

Heat the test tubes in a water bath for 5 minutes.



Note: Each tube is colored according to its glucose concentration, as shown in the image.

Conclusion: The color of a glucose solution changes when Benedict's solution is added to it, depending on the concentration of the sugar solution, as follows:

- Red: indicates a high concentration of glucose.
- Orange: indicates a medium concentration of glucose.
- Green: indicates a low concentration of glucose.
- Blue: indicates the absence of glucose.

Integration with Biology:

When glucose accumulates in the blood due to a lack of insulin secretion by the pancreas, this leads to diabetes.

Symptoms of Diabetes:

- 1- Significant weight loss.
- 2- Increased frequency of urination
- 3- Constant thirst



Starch Detection Activity

Tools: Potato, Iodine Solution, Dropper

Steps:

Cut the potato in half.

Place drops of the yellowish-brown iodine solution on the inside of the potato.



Note: The solution turns from yellowish brown to blue.

Conclusion

Potatoes contain starch, which turns the yellow-brown color of iodine solution into a deep blue.

Importance of Carbohydrates

Living organisms benefit from carbohydrates in many ways, as follows:

First: Their importance to living organisms:

- 1- A source of energy.
- 2- Supports brain function.
- 3- Cellulose forms plant cell walls.
- 4- It is a component of flower nectar.

Second: Their importance to industry:

They are used in many industries, such as the manufacture of:

- 1- Paper from cellulose
- 2- Cosmetics from sugars and starch
- 3- Drug capsules.

Nutritional awareness

It is recommended to reduce carbohydrates, such as white sugar and white flour, in the diet and to rely on whole grains.

Fats & Proteins

Second: Fats

Fats are an essential and important component of the nutrients you consume daily. Despite their harmful effects, they are essential for various bodily functions.

Fats: are organic chemical compounds that contain the same elements that make up carbohydrates

The most important sources of fat:

Olive oil

Eggs

Milk

Meat

Many types of nuts and vegetable oils



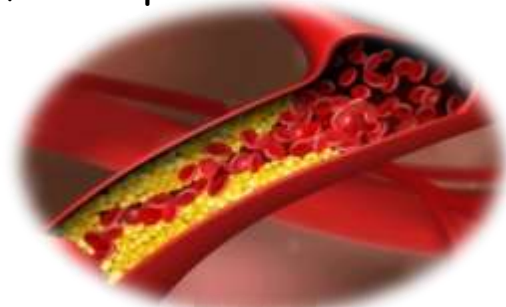
The importance of fats:

Fat provides the body with twice the energy as carbohydrates.

Cholesterol: A fatty substance found in body fat, its deposition in the arteries leads to blockage.

Cholesterol deposits inside the arteries.

This leads to clogged arteries and an increased risk of heart disease.



To maintain normal blood cholesterol levels:

1. Reduce your intake of fats and fried foods.
2. Exercise regularly.
3. Drink plenty of water.

Carbohydrates and fats are essential chemicals for transporting and storing energy in living organisms.

What happens when...? You consume more carbohydrates than your body needs.

The excess carbohydrates are stored in the liver and muscles as glycogen, or in your body's cells as fat, which is burned when needed, such as during fasting or dieting.

Fat Detection Activity

Tools: Egg yolk - Sudan IV solution - Distilled water - Test tube

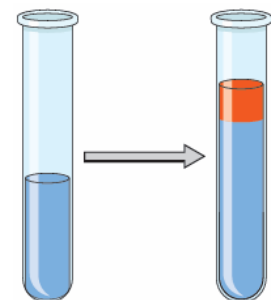
Steps

Place a portion of the fat-rich egg yolk in a test tube.

Add 10 ml of distilled water to make a mixture.

Add 10 ml of Sudan IV solution to the previous mixture.

What do you notice?



Note: A red-orange color forms on the surface of the mixture.

Conclusion

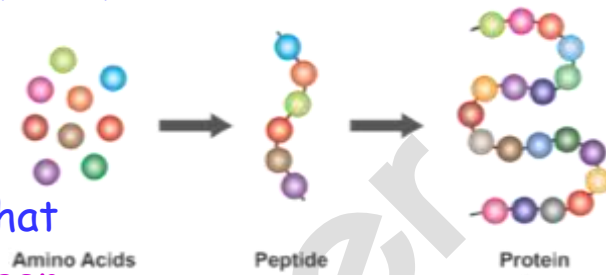
Sudan 4 solution turns a red-orange color on the surfaces of mixtures containing fats.

Third: Proteins

Proteins are among the most important substances the human body needs. They are involved in building muscles, skin, and hair and aid in vital processes within the body.

Proteins are composed of basic units called **amino acids**.

Amino acids consist of the same elements that make up **carbohydrates**, in addition to **nitrogen** and often **phosphorus**.



Protein Sources:

There are many sources of protein in food, whether animal or plant.

Animal Protein Sources

Red Meat	White Meat	Fish
Eggs	Milk and Dairy Products	

Vegetable Protein Sources

Legumes.	Nuts.	Soybeans.
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Note: Some people resort to using amino acid supplements to quickly build muscle, but excessive use of these supplements can cause serious risks to the kidneys and liver.



Protein Detection Activity

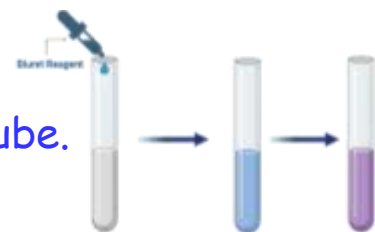
Tools: Egg albumen, Biuret solution, test tube.

Steps

Place a portion of egg white (rich in protein) in a test tube.

Add several drops of Biuret solution and stir gently.

What do you notice?



Note: The solution will change color from blue to purple.

Conclusion: Biuret solution changes color from blue to violet when added to proteins.

The Importance of Proteins to Living Organisms

- They are involved in building muscle and repairing and growing damaged cells.
- They are used in the formation of enzymes that act as catalysts.
- They are used in the formation of antibodies that support the immune system's resistance to disease-causing microbes.

The Importance of Proteins in Industry

- Genetic engineering is used to produce insulin, which is used to treat diabetes.
- Enzymes are used in the manufacture of laundry detergents to remove stains.
- Gelatin, used in the food industry, is extracted from proteins found in animal bones and hides.

Questions

Write the scientific term:

- (1) The branch of chemistry concerned with the study of the types of nutrients in meals. (.....)
- (2) The simplest form of carbohydrates. (.....)
- (3) Polysaccharides composed of two monosaccharide units. (.....)
- (4) Polysaccharides composed of 2 to 10 monosaccharide units. (.....)
- (5) Polysaccharides composed of more than 10 monosaccharide units. (.....)
- (6) The disease resulting from a deficiency in insulin secretion and the accumulation of glucose in the blood. (.....)
- (7) Polysaccharides that make up plant cell walls. (.....)
- (8) An organic food substance whose composition includes the same elements as carbohydrates. (.....)
- (9) A fatty substance whose deposition leads to clogged arteries. (.....)
- (10) Nutrients that are not considered a major source of energy. (.....)
- (11) An element found in proteins but not in carbohydrates. (.....)
- (12) Natural proteins used as catalysts. (.....)
- (13) The branch of science concerned with the manufacture of insulin. (.....)

Correct the underlined part:

- (1) Plant chemistry is concerned with the study of food substances. (.....)
- (2) Sulfur is a fundamental element in the composition of all food substances. (.....)
- (3) Glucose is the sugar of fruit. (.....)
- (4) When an oxygen molecule is removed from two monosaccharide units, a disaccharide unit is formed. (.....)
- (5) The color of Benedict's yellow solution changes in glucose solutions depending on their concentration. (.....)
- (6) Carbohydrates and lipids are essential materials for transporting and storing oxygen in cells. (.....)
- (7) Fatty acids are the basic building blocks of proteins. (.....)

Put (✓) or (X):

- (1) Grapes and potatoes are fruits rich in carbohydrates. ()
- (2) Sucrose is a monosaccharide found in grapes. ()
- (3) Excess glucose is stored in the stomach and muscles in the form of glycogen. ()
- (4) The average concentration of glucose turns orange when the appropriate reagent is added to it. ()
- (5) Increased urination may be a sign of insulin resistance. ()
- (6) Drug capsules are made of fat. ()
- (7) Sudan 4 solution turns a red-orange color on the surface of carbohydrates. ()
- (8) Phosphorus may be present in the composition of proteins. ()
- (9) Biuret solution is used to detect proteins present in egg yolk. ()
- (10) Enzymes and antibodies are carbohydrates. ()

What is meant by each of the following:

- (1) Nutritional Chemistry.
- (2) Monosaccharides.
- (3) Disaccharides.
- (4) Oligosaccharides.
- (5) Polysaccharides.
- (6) Cholesterol

State one importance for each of the following:

- (1) Potatoes in nutrition.
- (2) Benedict's solution.
- (3) Iodine solution.
- (6) Carbohydrates for plant cells
- (5) Carbohydrates for the brain.
- (4) The pancreas.
- (7) Carbohydrates for flowers.
- (8) Carbohydrates for the pharmaceutical industry.
- (9) Vegetable oils in nutrition.

Give Reason for:

- (1) Glucose is one of the simplest forms of carbohydrates.
.....
- (2) Maltose is a disaccharide.
.....
- (3) Starch is a polysaccharide.
.....
- (4) Benedict's solution produces several colors with glucose solutions.
.....
- (5) Diabetes is caused by a hormonal imbalance.
.....
- (6) Iodine solution is used to detect the presence of starch in food.
.....
- (7) The similarity of the constituent elements of carbohydrates and fats.

U3: Energy flow in photosynthesis

& culler respiration

L1: Photosynthesis

Van Helmont's Experiment and Chloroplasts

Until the 17th century, scientists believed that plants obtained their nutrients from the soil, until the Belgian scientist **Van Helmont** conducted an experiment proving otherwise.



Van Helmont's Experiment

1. Van Helmont took a willow seedling weighing 2.2 kg and planted it in a container containing dry soil weighing 90 kg.
2. He watered the tree with water only for 5 years without adding any other substances.
3. He weighed both the tree and the soil again after 5 years.

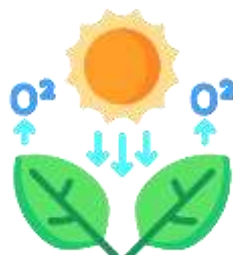


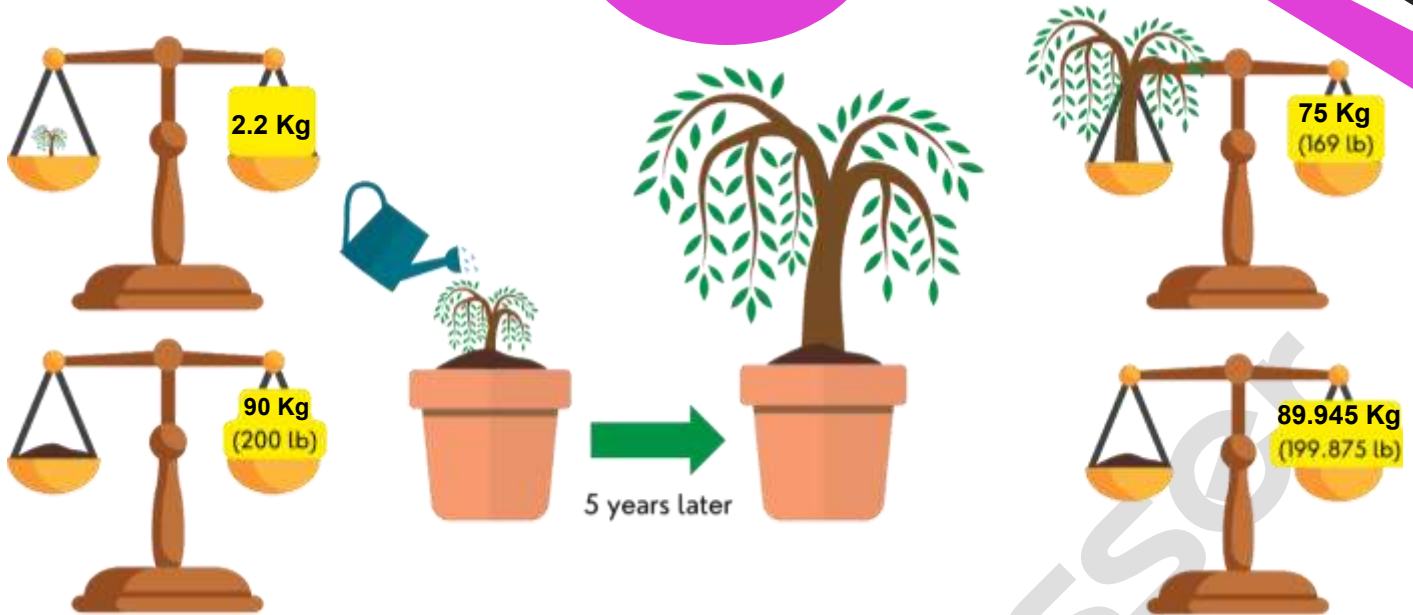
Experiment Results:

He found that the tree's mass had increased to 75 kg, while the soil's mass had decreased by only 55 g.

From his experiment, Helmont concluded that:

1. Tree growth does not depend primarily on the absorption of nutrients from the soil.
2. The slight decrease in soil mass is due to the plant absorbing small amounts of soil elements.
3. **Water** is the essential element for tree growth.





Later research by scientists revealed that:

1. Plants also use carbon dioxide and sunlight to make their own food through **photosynthesis**.
2. Photosynthesis takes place in organelles called **chloroplasts**.

Chloroplasts are found in:

- The cells of the green parts of plants, especially leaves and herbaceous stems, such as **Mallow (Molokhia)**.



Two types of vessels perform the transport function within the plant:

Xylem vessels: transport water and mineral salts from the plant roots to the rest of the plant.

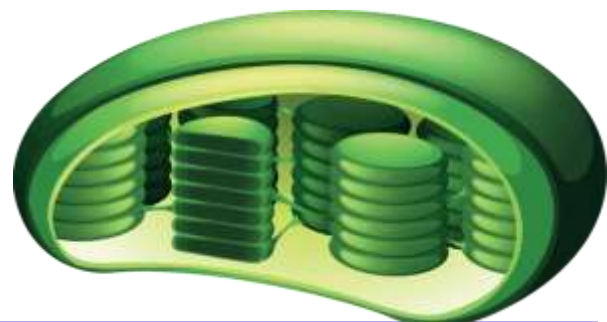
Phloem vessels: transport food from the leaves to the rest of the plant.

Chloroplasts

Plant cells are characterized by the presence of chloroplasts.

Chloroplasts

Lentil-shaped cell organelles found in the cells of the green parts of plants and also in green algae.

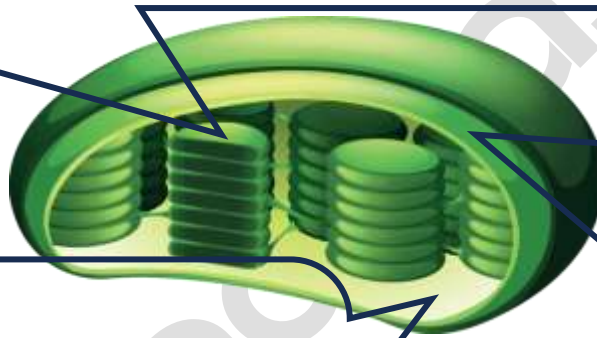


Grana: Composed of structural units called **thylakoids**, numbering up to 15 or more.

The edges of some grana thylakoids extend to meet the edges of another thylakoids in neighboring grana via thin membranes. This increases the surface area of the discs exposed to light.

Function of grana:

A number of light-dependent reactions take place in the grana. The thylakoids membranes contain several types of pigments, including the green pigment chlorophyll.



Stroma

It is the floor of the plastid and contains most of the **enzymes** needed for the group of reactions that do not require light, called light-independent reactions.

The double membrane

allows materials to move into and out of the plastid.

Plastids are classified according to the pigments they contain

Chloroplasts

It is found in the cells of the green parts of plants and green algae.



Chromoplasts

It is found in some fruits, such as plums and flower petals. It is found in some fruits, such as plums and flower petals.



Leucoplasts

It is found in potatoes and sweet potatoes.



Activity: Light Absorption by Chlorophyll

Tools: Spinach leaves, ethyl alcohol (ethanol), test tube, filter paper, Light bulb, porcelain pot, colored transparent sheets.



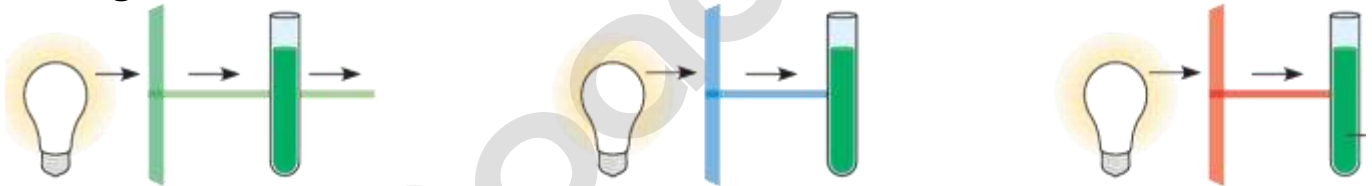
Steps:

- 1) Chop some spinach leaves, then place them in a mortar and pestle.
- 2) Add enough alcohol to cover the spinach leaves.
- 3) Pound the leaves with a pestle and mortar until a green mixture forms.

Note: The green color of the mixture is formed because spinach leaves contain the green pigment chlorophyll.

- 4) Use filter paper to separate the clear green solution into a test tube.

- 5) Place a red transparency between the lamp and the tube containing the clear green solution to allow only red light to pass through.



- 6) Repeat step (5) using a blue transparency again. What do you notice?

Note: Red and blue light do not pass through the green chlorophyll solution.

- 7) Repeat step (5) using a green transparency again. What do you notice?

Note: Green light passes through the green chlorophyll solution.

Conclusion

The transparent green chlorophyll solution allows only **green** light to pass through.

The transparent green chlorophyll solution absorbs **red and blue** light.

- To use their energy in the photosynthetic reactions that take place in the grana and convert light energy into chemical energy stored in **glucose**.

Integration with Physics:

Light is a form of energy.

White light consists of seven colors called the colors of the spectrum.

When white light falls on one of the faces of a triangular glass prism, it **decomposes** into the **seven colors** of the spectrum, arranged according to their energy, as shown in the figure below.



The Behavior of White Light When It Falls on Opaque, Transparent, and Semi-Transparent Colored Materials:

Opaque Objects	Transparent and Semi-Transparent Objects
Opaque colored objects absorb all colors of the spectrum, reflecting only their own color. This is why plant leaves appear green.	Transparent and translucent colored objects absorb all colors of the spectrum of white light and allow only their own color to pass through. Therefore, a transparent green chlorophyll solution absorbs red and blue, allowing only green to pass through.

Plant leaves appear green

because they contain the pigment chlorophyll, which absorbs all colors of white light and reflects only green.

White light is considered a composite light

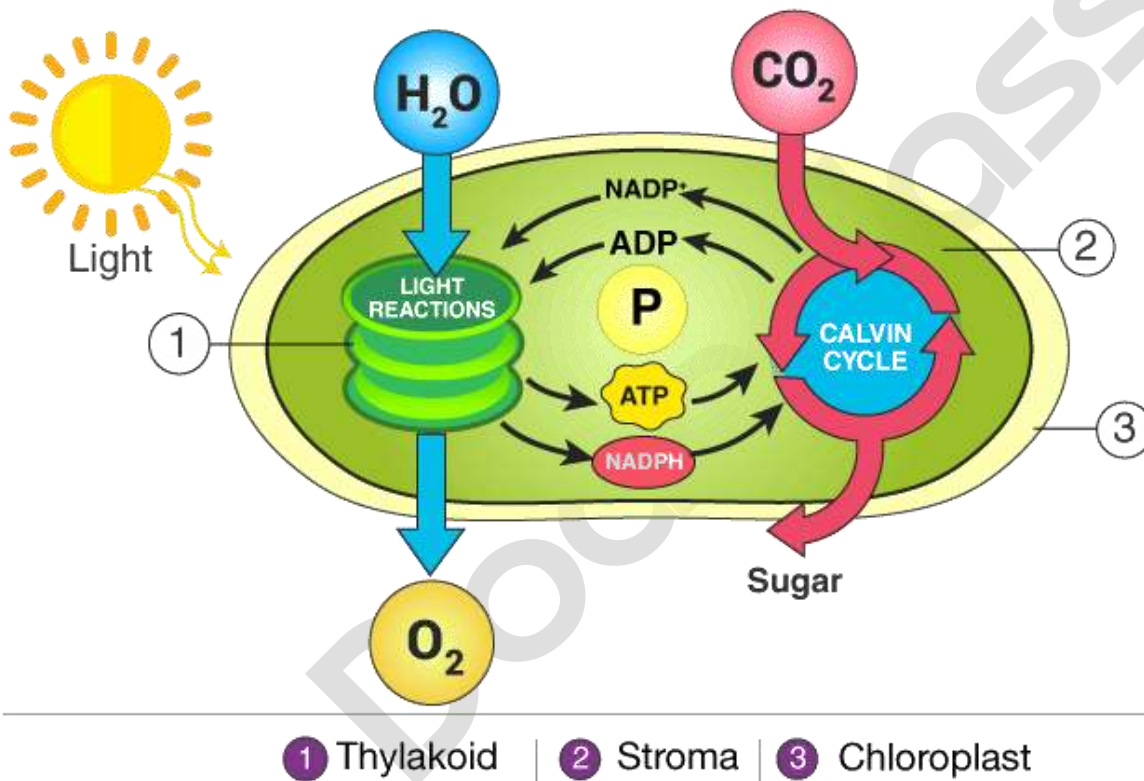
because it consists of seven colors known as the colors of the visible spectrum.

The mechanism of photosynthesis and the factors affecting it

Mechanism of Photosynthesis

Photosynthesis occurs in two stages:

1. The light- dependent reactions: These occur in the grana on the disc membranes.
2. The light-independent reactions: These occur in the stroma.



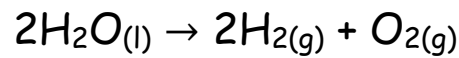
The lightdependent reactions

These occur in the **grana** on the **thylakoids**. These reactions are known as **light-dependent reactions**.

1

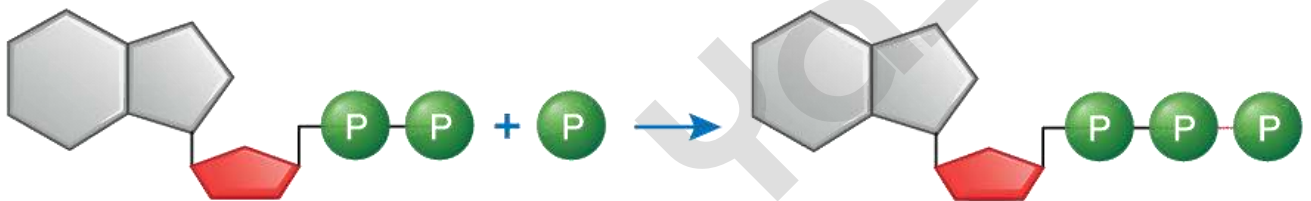
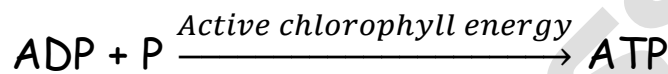
Chlorophyll absorbs the energy of blue light and red light from visible light, and chlorophyll becomes active (excited).

Part of the energy of active chlorophyll is used to break down water into oxygen and hydrogen.



Oxygen is released into the atmosphere as a byproduct.

The remaining energy from active chlorophyll is used to convert a compound called adenosine diphosphate (ADP) into adenosine triphosphate (ATP), by adding a P-phosphate group to it.



The resulting ATP molecule is used in the light-independent reactions.

Note: ATP is an abbreviation for Adenosine Triphosphate, a molecule that carries energy inside the cell. Cells use it to perform all vital activities, such as movement, growth, and building materials.

ADP	ATP
Both are molecules in the cell made up of: A nitrogenous base (adenine) A five-carbon sugar (ribose)	
ADP molecule contains two phosphate groups (diphosphate).	An ATP molecule contains 3 phosphate groups (triphosphate).

Integration with Chemistry:

When an electron in a single atom gains energy, it moves from its original energy level to a higher energy level.

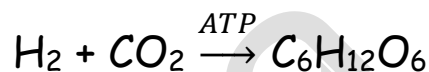
The atom in this state is called an **excited atom** and is unstable; therefore, the electron quickly loses the energy it gained and returns to its original energy level, leaving the atom unexcited.

The lightindependent reactions

A set of chemical reactions that do not depend on the presence of light, known as light-independent reactions, take place in the stroma, as follows:

1 Hydrogen carried by one of the chemical compounds present on the thylakoids membranes is transferred to the stroma.

2 Hydrogen combines with carbon dioxide absorbed from the air in the presence of both the ATP molecule produced from the light-dependent reactions and the enzymes present in the stroma, to form glucose ($C_6H_{12}O_6$).



In the process of photosynthesis, the plant rearranges (assembles) the atoms it obtained from simple molecules, which are the molecules of water absorbed from the soil and carbon dioxide absorbed from the atmosphere) in the presence of sunlight to form its food (glucose sugar) and release oxygen gas as a secondary product, according to the following equation: $6H_2O + 6CO_2 \xrightarrow{\text{chlorophyll}} 6O_2 + C_6H_{12}O_6$

Glucose produced by the light-dependent reactions dissolves in cold water. Therefore, if glucose remained in this form, it would dissolve in plant sap.

Therefore, many glucose molecules are linked together in long chains, forming starch granules that are poorly soluble in cold water.

Starch is stored in the leaves, roots, and stems, with storage efficiency being high in taro leaves, potato roots, and potato stems.

Integration with Chemistry:

Enzymes are protein molecules that act as catalysts that increase the rate of light-induced reactions without the need for the high temperatures required for such reactions in research laboratories.

Starch Formation in Photosynthesis

Light is necessary for the formation of starch in plant leaves during photosynthesis.

To determine the presence of starch in plant leaves, we conduct the following experiment.

Tools: Verticillata leaf, tap water, iodine solution, glass beakers, ethyl alcohol (ethanol), heat source, dropper, forceps (holder), test tube

We take a leaf of a variegated plant exposed to light for a sufficient period of time, then put it in boiling water for two minutes to break down the cell walls.

The leaf is transferred to a test tube containing ethanol, and the tube is heated in a hot water bath until the green chlorophyll color is removed from the leaf to facilitate observing any color change that occurs.

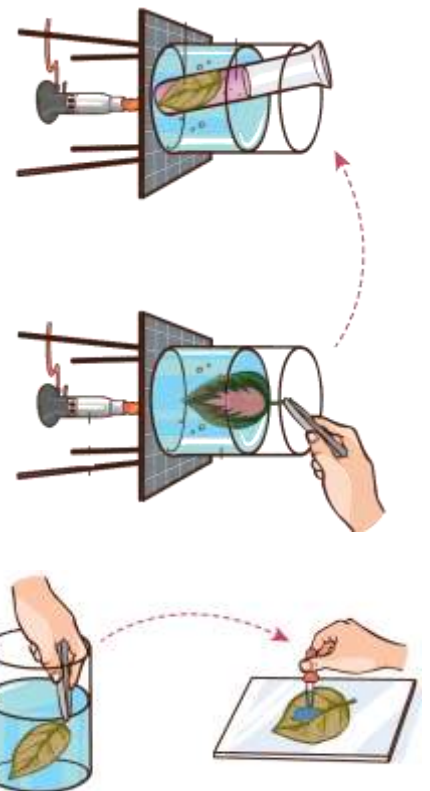
Remove the paper from the ethanol and wash it with water to remove any remaining ethanol and soften it again.

Use a dropper to add drops of iodine solution to the paper.

Note: The green areas of the leaf change to a dark blue color when iodine solution is added.

The non-green parts remain the original iodine color unchanged.

Conclusion: The green parts of the plant contain chlorophyll and thus carry out photosynthesis, which results in the formation of starch.



The iodine color changes to dark blue in only the green areas of the variegated leaf. This indicates that starch is being produced only in the green parts.

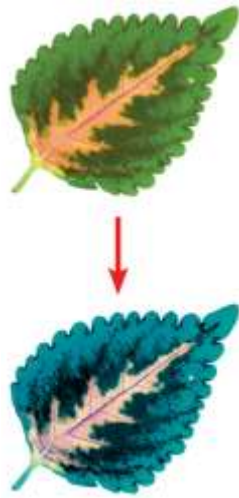
What happens if...? We performed the same experiment after covering a portion of the paper with light-blocking tape before beginning the experiment.

The covered portions that were not exposed to light will not form starch, and therefore, the iodine will not react with them to produce the dark blue color.

This confirms that light is essential for photosynthesis and starch formation.

We conclude from the previous experiment the importance of each of the following:

1. Chlorophyll in starch formation, evidenced by the fact that the iodine color in the green areas of the variegated leaf turns dark blue.
2. Light in starch formation, evidenced by the fact that the iodine color does not change in the areas covered by the tape.

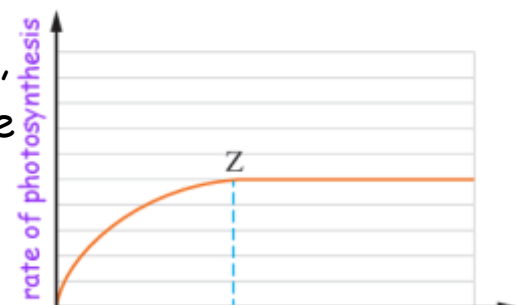


Factors affecting the process of photosynthesis

1) Illumination Intensity (Light)

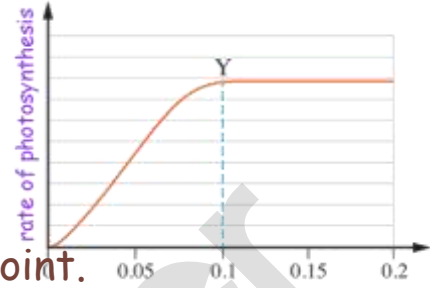
When light intensity increases, the rate of photosynthesis increases.

- At a certain point (point (z), the rate of photosynthesis reaches its maximum, the optimal rate of photosynthesis).
- Point (z) represents the light saturation point, where all light-absorbing sites in chlorophyll are occupied and operating at maximum efficiency.



2) Carbon dioxide (CO_2) concentration

- When the carbon dioxide concentration increases, the rate of photosynthesis increases.
- At a certain point (point Y), the CO_2 concentration is 0.1%, and the rate of photosynthesis reaches its maximum, the optimum rate of photosynthesis.
- Point Y represents the carbon dioxide saturation point.

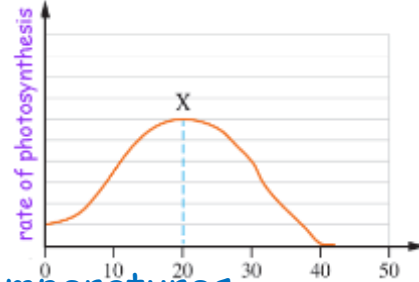


3) Temperature

When the temperature increases, the rate of photosynthesis increases.

At a certain point (point X), where the temperature is approximately (20), the rate of photosynthesis reaches its maximum. Point (X) represents the optimum temperature for the enzymes responsible for photosynthesis.

When the temperature exceeds the optimum point (point (X)), the rate of photosynthesis decreases sharply, and may even stop completely at very high temperatures greater than 40°C due to damage to the enzymes involved in photosynthesis.



The effect of low light on both light-dependent & light-independent reactions in plants:

When light decreases, photosynthetic reactions are affected. The amount of energy (ATP) decreases, which reduces the production of oxygen and the energy needed for photosynthetic reactions. This leads to a decrease in glucose production, and consequently, a decrease in the plant's growth rate.



Technological Application

Vertical Farming

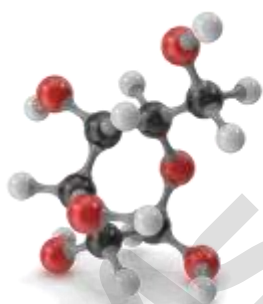
Vertical farming: A newly developed technology in advanced cities that mimics the conditions suitable for agriculture, enabling photosynthesis to be performed, producing vegetables and fruits in multi-story buildings using artificial lighting and hydroponic nutrients.



Importance:

It provides a sustainable solution to the shortage of suitable agricultural land.

Design a model of the materials involved in photosynthesis. Collaborate with your classmates, under the supervision of your teacher, to use the ball-and-stick models provided to design models representing the reactants and products of photosynthesis.



Questions

Write the scientific term:

- (1) The specialized organelles in which photosynthesis takes place. (.....)
- (2) The floor of chloroplasts surrounded by an inner membrane. (.....)
- (3) The reactions that take place in the matrix, without the need for light. (.....)
- (4) The building blocks of grana. (.....)
- (5) The structures in which light reactions occur in chloroplasts. (.....)
- (6) The pigment responsible for absorbing light in photosynthesis. (.....)
- (7) The atom in which an electron transitions from its stable energy level to a higher energy level. (.....)
- (8) The unit formed by linking an adenine unit with a ribose sugar unit. (.....)
- (9) The protein molecules that increase the speed of light-dependent reactions in plants. (.....)
- (10) The energy molecules used to rearrange atoms in photosynthesis. (.....)

Correct the underlined part:

- (1) In Helmont's experiment, the mass of the willow seedling increased by approximately 50 kg. (.....)
- (2) In Helmont's experiment, the mass of the soil used decreased by 100 g. (.....)
- (3) Helmont demonstrated that plant growth does not depend primarily on the absorption of water from the soil. (.....)
- (4) Each grana consists of at least five thylakoids. (.....)
- (5) Flower petals contain colorless plastids. (.....)
- (6) In the chlorophyll extraction experiment, spade leaves are crushed in a copper mortar. (.....)
- (7) Opaque colored objects transmit light of the same color. (.....)
- (8) The absorption of protons by a stable atom transforms it into an excited atom. (.....)

Put (✓) or (X):

- (1) Then Helmont's special experiment on a willow seedling. ()
- (2) The lack of atmospheric humidity in the Helmont Large Block experiment is due to the origins of atmospheric humidity. ()
- (3) Water and mineral salts are factors affecting photosynthesis. ()
- (4) Chloroplasts are surrounded by a double membrane. ()
- (5) They suffer from some damage to the grana film in cinema films. ()
- (6) They are densely packed with various types of pigments. ()
- (7) Sweet potato peels contain plastids. ()
- (8) Red transparencies can transmit red light. ()
- (9) An ATP molecule consists of an adenosine unit linked to two phosphate groups. ()
- (10) Filling reactions in chloroplasts involve water molecules. ()

What is meant by each of the following:

- (1) White light analysis.
- (2) Excited atoms.
- (3) ADP molecules.
- (4) ATP molecules.
- (5) Enzymes.
- (6) Vertical farming.

State one importance or use for each of the following:

- (1) Water for plants.
- (2) Soil for plants.
- (3) Stroma (filling) in chloroplasts.
- (4) The double membrane of chloroplasts.
- (5) Grana.
- (6) Grana thylakoids membranes.
- (7) Triangular glass prism.
- (8) Chlorophyll in photosynthesis.
- (9) Enzymes in the filling of chloroplasts.
- (10) Chloroplasts.

Give Reason for:

- (1) A slight decrease in the mass of soil used in the Helmont experiment.
.....
- (2) Stroma (filling) reactions are called photochemical reactions.
.....
- (3) The edges of some grana discs are connected by thin membranes.
.....
- (4) Flower petals are colored.
.....
- (5) A green solution is formed when ethyl alcohol is added to pieces of spinach leaves.
.....

L2: Cellular Respiration

Gas exchange and cellular respiration

Plants do not have a specialized respiratory system, but they obtain the oxygen they need for respiration from the air through natural openings in the leaves called stomata. There is a difference between the process of respiration (gas exchange) and the process of cellular respiration, in which energy is produced.

Gas exchange in plants

A vital process in which carbon dioxide and oxygen are exchanged with the surrounding environment to complete photosynthesis during the day and respiration during the day and night.

Gas Exchange Activity

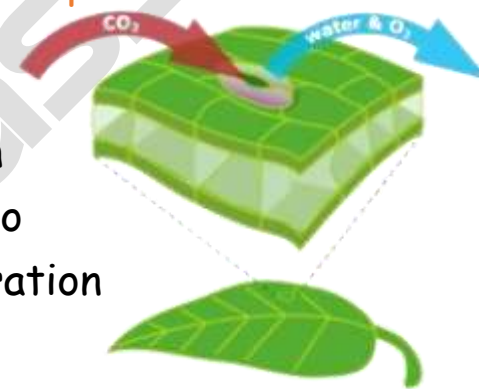
Tools: 3 plant pots of the same type - 3 clear glass bell jars - a beaker containing clear limewater solution - a beaker containing methylene blue solution - a Petri dish containing sodium lime (a mixture of sodium hydroxide and calcium oxide).

Steps: Place the beaker containing clear limewater solution next to pot (1) and cover them with the first bell.

Place the beaker containing methylene blue solution next to pot (2) and cover them with the second bell

Place the dish of sodium lime next to pot (3) and cover them with the third bell.

This activity is conducted once in the presence of light and once in the absence of light.



Conclusion

1 - Gas exchange occurs during the day and night in the process of respiration; the plant obtains oxygen and releases carbon dioxide.

This can be inferred from:

- The plant consumes oxygen in the process of respiration; from the discoloration of the methylene blue solution at night.
- The formation of carbon dioxide in the process of respiration; from the turbidity of the clear limewater solution at night.

2 - Gas exchange occurs only during the day in the process of photosynthesis due to the availability of sunlight; the plant obtains carbon dioxide and produces oxygen.

3 - The rate of photosynthesis decreases during the day in Figure (3) because the sodium lime and sodium hydroxide solution absorb a quantity of carbon dioxide from the surrounding environment.

Integration with Chemistry

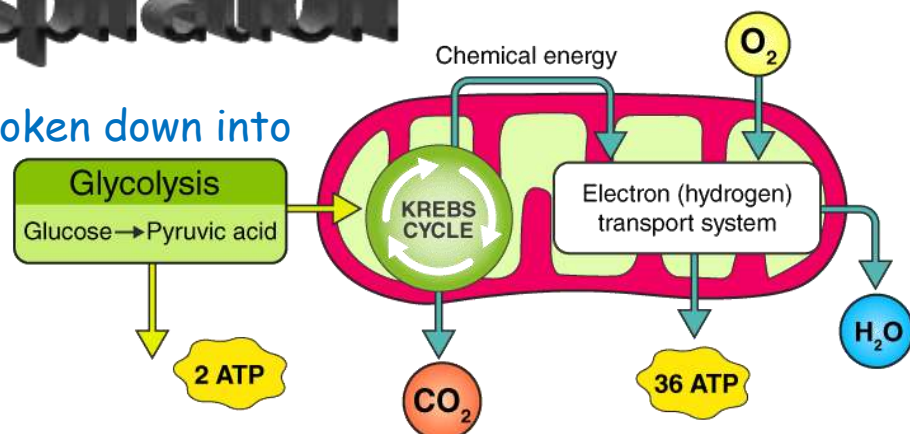
Clear limewater solution turns cloudy when carbon dioxide gas is passed through it.

Methylene blue solution loses its color when oxygen is absent from the surrounding medium.

Sodium lime and sodium hydroxide solution are substances that absorb carbon dioxide gas from their surrounding medium.

Cellular Respiration

Large food molecules are broken down into smaller molecules in cellular respiration.



Cellular Respiration

The process by which large food molecules, such as glucose, are broken down within living cells in the presence of oxygen. The atoms are rearranged to form water and carbon dioxide, releasing a large amount of energy in the form of ATP molecules.

Most of the cellular respiration process takes place inside mitochondria.

Mitochondria: are specialized, bean-like organelles found in most cells that function as power plants for producing energy from food.

Outer membrane:

- A flat membrane whose functions:
 1. Protect the components of the mitochondria.
 2. Regulate the entry and exit of materials.



Matrix:

- A fluid found within the inner membrane of mitochondria.
Function: Contains enzymes used to catalyze reactions occurring within mitochondria.

Inner membrane:

- A wavy membrane that forms folds called cristae.

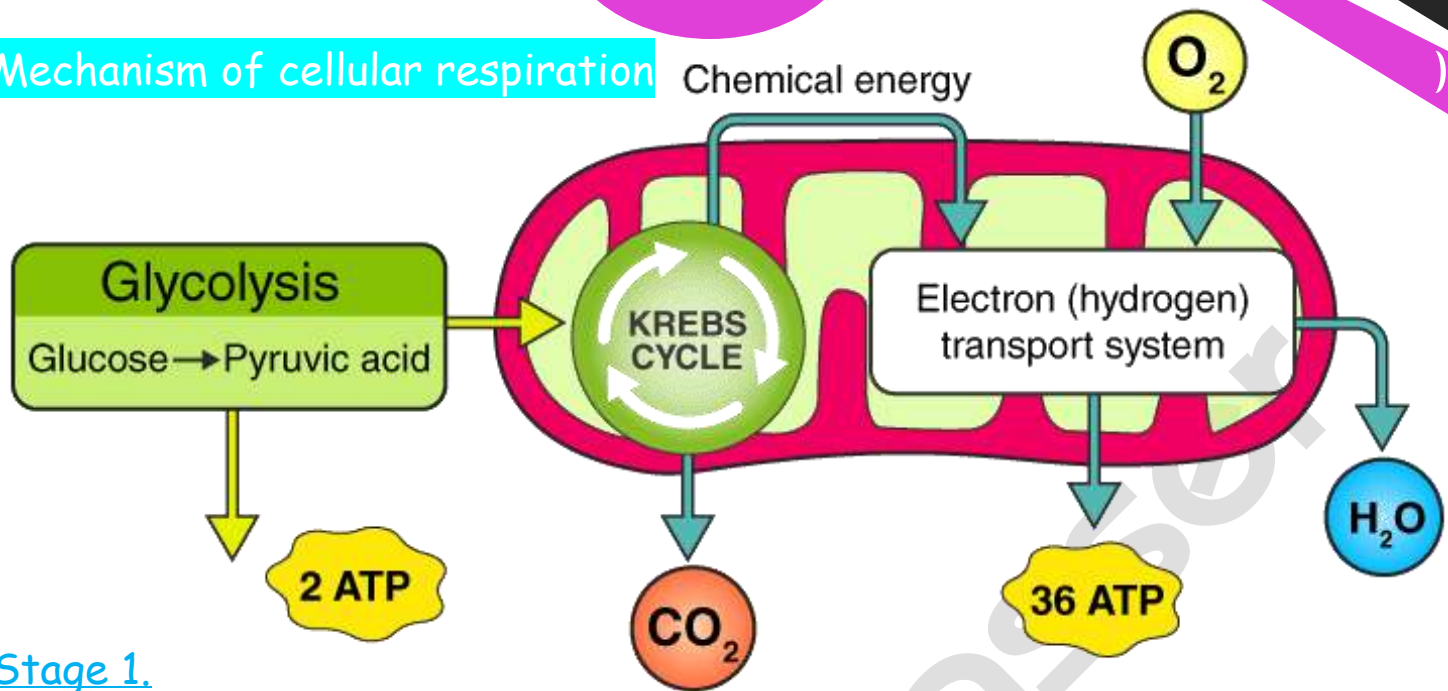
The function of the cristae is to increase the internal surface area of the mitochondria, increasing energy production.

Note: The number of mitochondria increases within some cells that require a large amount of energy, such as liver and muscle cells.

The inner membrane of mitochondria contains folds that increase its surface area.

These folds (cristases) enhance energy production in cellular respiration with high efficiency.

Mechanism of cellular respiration



Stage 1.

Where it occurs: It takes place in the cytoplasm in the **absence of atmospheric oxygen**. **What happens during it...?**

- Each glucose molecule is broken down in the presence of water, through a series of chemical reactions, into two molecules of pyruvic acid, in addition to the release of limited energy in the form of ATP molecules.

The pyruvic acid is then transported to the **mitochondria**.

Stage 2.: Where it occurs: It takes place in the mitochondria in the presence of oxygen. **What happens during it...?**

- Two types of reactions take place:

Krebs cycle reactions

Where it occurs:

It takes place in the mitochondrial matrix.

What happens during it...?

- Chemical reactions in which pyruvic acid is broken down.

Its products:

- 1 - A limited amount of energy in the form of ATP molecules
- 2 - Carbon dioxide gas, which is released into the atmosphere

Electron transport chain reactions

Where it occurs:

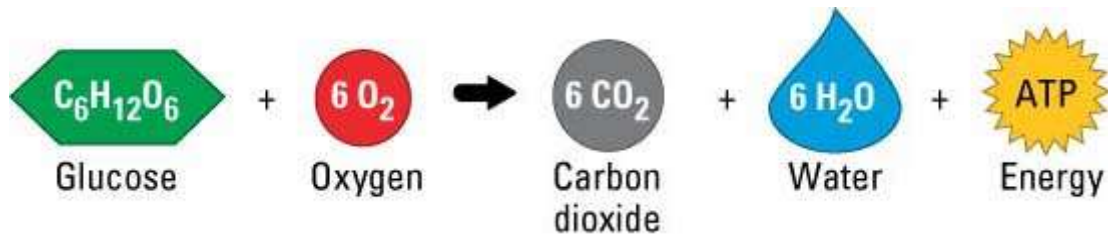
It takes place on the inner membrane of the mitochondria.

What happens during it...?

Electrons produced by the Krebs cycle contribute to the production of energy and water.

Products:

- 1 - A large amount of energy in the form of ATP molecules
- 2 - Water



Energy and metabolism

Living organisms need energy to carry out all vital processes, such as growth and movement.

This occurs through several **chemical reactions** that occur in the body's cells, including **anabolism** and **catabolism** processes known as metabolism.

ANABOLISM

Processes in which the energy of ATP molecules is consumed in building a large, complex molecule from many simple molecules.

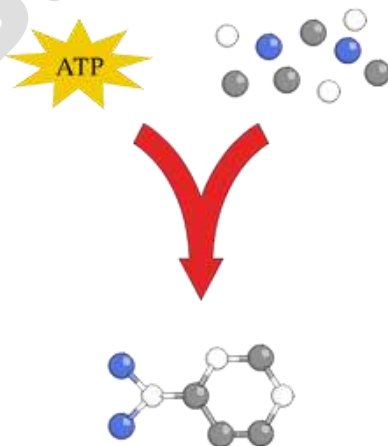
- 1 - Glycogen is formed from glucose.
- 2 - Proteins are formed from amino acids in the cytoplasm.
- 3 - ATP molecules are formed from ADP molecules.

CATABOLISM

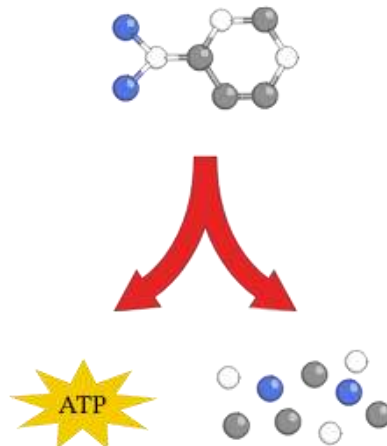
Processes in which the energy of ATP molecules is released from the decomposition of a previously built large molecule into simpler molecules.

- 1 - Breakdown of glucose molecules in cellular respiration
- 2 - Breakdown of protein molecules and glycogen molecules in digestion

Anabolic reaction



Catabolic reaction



Note:

The process of breaking bonds in glucose molecules is accompanied by the **absorption of energy**, because breaking chemical bonds requires energy.

While the process of glucose breakdown is accompanied by the **release of energy**?

Because the breakdown process involves breaking chemical bonds, forming new bonds, and releasing energy.

The breakdown of nutrients such as glucose involves breaking and forming new bonds, so the breakdown process is accompanied by the formation of new products and the release of energy.

Technology Application: Metabolic Rate Analyzer

A device that provides accurate data on resting metabolic rate (RMR) that helps with:

Effective diet and exercise planning for more successful and sustainable weight management.



Questions

Write the scientific term:

- (1) A living organism obtains oxygen from the atmosphere and gets rid of carbon dioxide. (.....)
- (2) The process of gas exchange in living organisms that occurs day and night. (.....)
- (3) A gas exchange process that occurs only during the day in plants and green algae. (.....)
- (4) A solution that loses its color when oxygen is absent. (.....)
- (5) Specialized organelles resembling beans found in most living cells. (.....)
- (6) Folds found on the inner membrane of mitochondria. (.....)
- (7) Chemical reactions that take place in the mitochondrial matrix that produce a limited amount of energy. (.....)
- (8) Reactions that convert glucose to pyruvic acid in the cytoplasm of living cells. (.....)
- (9) Reactions that take place on the inner membrane of mitochondria, producing a large amount of energy. (.....)
- (10) The set of chemical reactions that take place within the cells of an organism to carry out all vital processes. (.....)

Correct the underlined part:

- (1) In photosynthesis, a O_2 gas from the atmosphere is exchanged for CO_2 . (.....)
- (2) Chloroplasts are the energy-producing plants. (.....)
- (3) Pyruvic acid is hydrolyzed in the first stage of cellular respiration. (.....)

Put (✓) or (X):

- (1) Gas exchange occurs in plant leaves through stomata. ()
- (2) Sodium hydroxide solution absorbs carbon dioxide from the surrounding environment. ()
- (3) Both chloroplasts and mitochondria are surrounded by a double membrane. ()
- (4) The mitochondrial matrix is rigid and contains enzymes. ()
- (5) In the first stage of cellular respiration, each glucose molecule is broken down into two molecules of pyruvic acid. ()
- (6) Part of cellular respiration takes place in the cell's cytoplasm. ()
- (7) The Krebs cycle occurs in the first stage of cellular respiration. ()

(8) The reactions of the electron transport chain take place in the first stage of cellular respiration. ()

(9) A limited amount of energy is generated in the second stage of cellular respiration. ()

(10) The processes of photosynthesis are called metabolic processes. ()

What is meant by each of the following:

(1) Gas exchange process.

(2) Cellular respiration.

(3) Mitochondria.

(4) Metabolism.

(5) Catabolic processes.

(6) Anabolic processes.

State one importance or use for each of the following:

(1) Leaf stomata.

(2) Clear limewater solution.

(3) Methylene blue solution.

(4) Sodium lime.

(5) Mitochondria.

(6) Cellular respiration.

(7) Mitochondrial outer membrane.

(8) Mitochondrial cristae.

(9) Mitochondrial cytoplasmic enzymes.

(10) Mitochondrial matrix.

Give Reason for:

(1) Gas exchange occurs in plants despite their lack of a respiratory system.

(2) Cloudiness of clear limewater placed inside a closed container with a green plant in a dark place.

(3) Change in the mass of a sample of sodium lime when left with a green plant in a closed container in a dark place.

(4) Differences between cellular respiration and photosynthesis in the input and output of exchanged gases.

(5) No photosynthesis occurs when a green plant is placed with a sodium hydroxide solution in a closed container.

(6) Death of a mouse placed with a green plant in a dark bell jar after several days.

(7) Differences in the organelles of a single cell in plant leaves where cellular respiration and photosynthesis occur.

U4: Geological Processes

Change the Earth's surface

The topography of the Earth's surface has changed over millions of years as a result of numerous geological processes, until it took its current form. How did these changes occur? And how do scientists explain them?

With the evolution of the world map over time, the German scientist **Alfred Wegener** proposed a hypothesis he called **continental drift**.

Continental Drift Hypothesis

Wegener proposed his famous hypothesis of continental drift in 1912, which states:

200 million years ago: The Earth was a single, massive continent called Pangaea, which then began to drift apart over time.

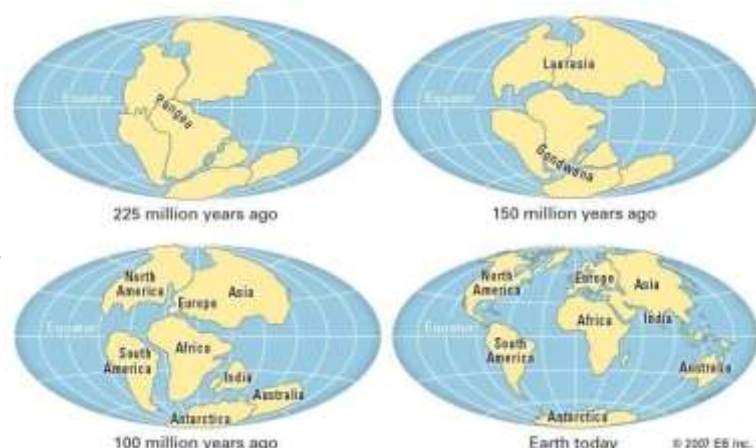
135 million years ago, the continents of Africa and South America began to separate, forming the Atlantic Ocean.

Over time, the separation increased, and the continents became as they are today.

We note from the figure the following:

1 - Continents existed, but they were a single, connected continent.

2 - The continents moved over millions of years, gradually moving away from each other, which led to changes in the shape of the Earth and the formation of oceans such as the Atlantic.



Wegener was unable to explain how the continents moved apart until the emergence of the theory of **plate tectonics**, which is considered the modern development of the continental drift hypothesis.

Some rocks on the western side of Africa and the eastern side of South America contain similar remains of very ancient organisms. **This indicates that both were once a single mass in ancient times.**

Tectonic plates theory

The theory of plate tectonics is based on several assumptions, namely:

The lithosphere (lithosphere) consists of:

(1) The Earth's crust layer. The Earth's crust layer is divided into:

- Continental crust (land covered by the atmosphere).
- Oceanic crust (land covered by the hydrosphere).

(b) The solid part of the upper mantle.

2

The lithosphere consists of solid plates of different thicknesses and areas known as tectonic plates.

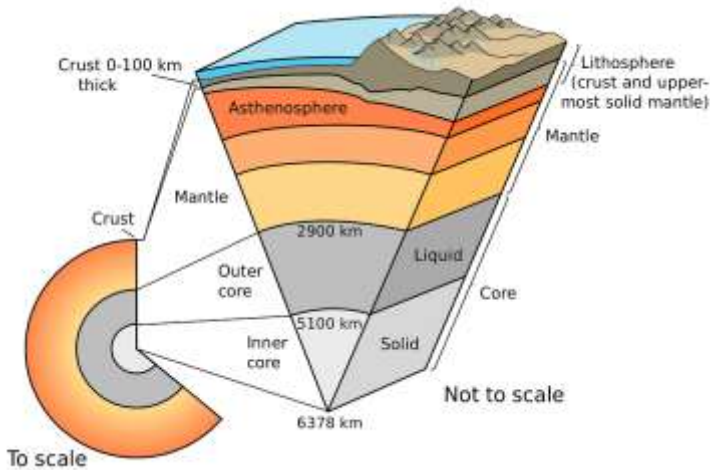
3

Tectonic plates are divided into:

- **Continental plates:** composed of thick, low-density continental crust and a portion of the upper mantle.
- **Oceanic plates:** composed of thin, high-density oceanic crust and a portion of the upper mantle.

4

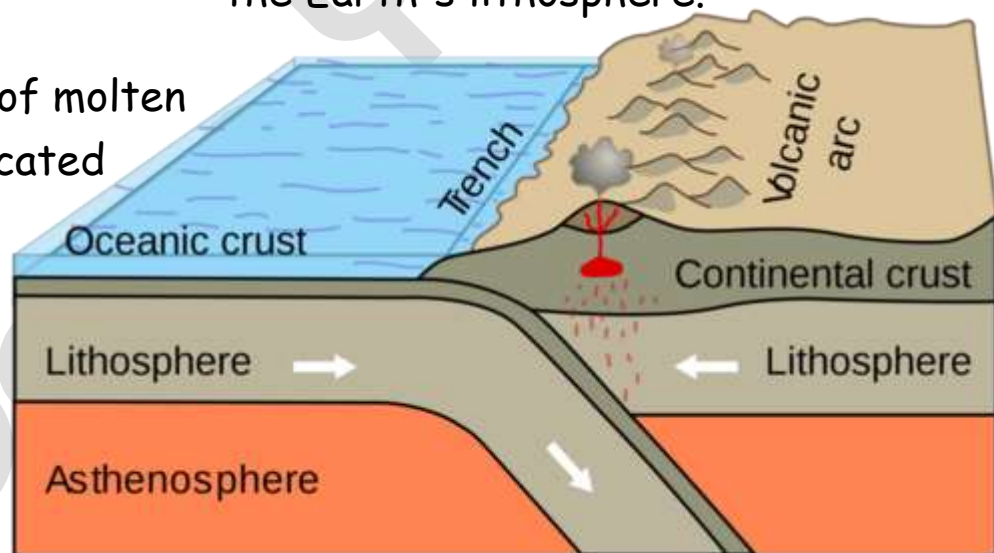
Tectonic plates move in a slow, continuous, and imperceptible motion relative to each other above a layer of molten rock (magma) called the asthenosphere, as a result of the movement of convection currents in the asthenosphere.



Lithosphere: The lithosphere, which consists of the Earth's crust and the solid part of the upper mantle.

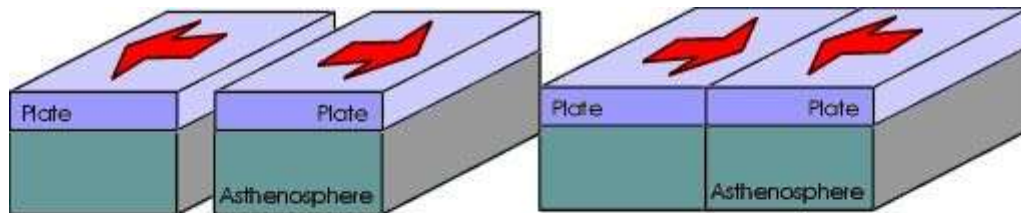
Tectonic Plates: Solid plates of varying thickness and area make up the Earth's lithosphere.

Asthenosphere: A layer of molten rock known as magma, located beneath the Earth's lithosphere.



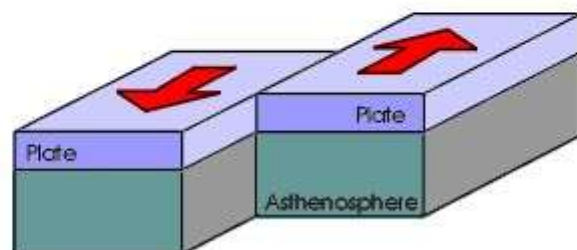
Tectonic Plate Movement

The movement of tectonic plates affects changes in the Earth's surface through the flow of magma beneath them. This movement is classified into three types:



Divergent

Convergent



Transform

Divergent movement

The movement of tectonic plates away from each other.

Areas where plates diverge are called **divergent boundaries**.



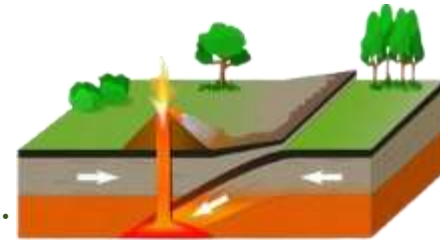
Their cause:

The divergence between two continental plates occurs due to upwelling currents.

Their results include:

1. New oceanic crust, such as the formation of the **Red Sea** in Africa.
2. New continental crust, such as the formation of the **Great African Rift Valley**.

The **Red Sea** gets its name from the abundance of red algae found there and the reflection of the red mountains and rocks on its coasts, especially in Sinai.



Convergent movement

The movement of tectonic plates toward each other.

- The areas where plates converge are called convergent boundaries.

- Causes:

- Occurring due to downward convection currents, where two plates meet, one slides beneath the other.

- Results:

1. In the case of two continental plates converging,
 - Mountain ranges such as the **Himalayas** are formed.



2. In the case of two oceanic plates converging,

- New chains of volcanic islands are formed. Example: the formation of the **islands of Japan**.

3. In the case of an oceanic plate converging with a continental plate:

- The denser oceanic plate dives (slips) beneath the less dense continental plate, causing the formation of mountain ranges such as the **Andes Mountains**.

The Himalayas are higher than the Andes because of their **higher peaks**, while the Andes are longer than the Himalayas because of their **geographic extension**.

3. Convergent Movement

The movement of tectonic plates along (side by side)

- Areas where plates move along are called **convergent boundaries**.

Results:

Long fault lines, such as the **San Andreas Fault** in California.

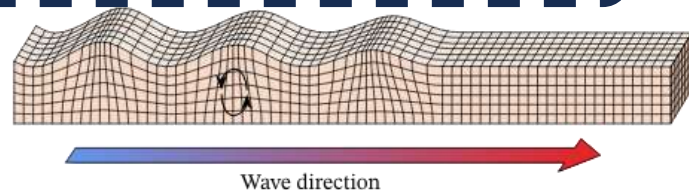
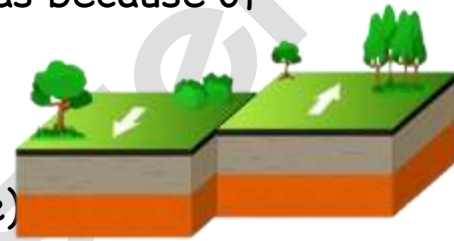
Geologists predict new changes in the Earth's topography as tectonic plate movement continues. Examples of these predictions include:

1. The Red Sea will transform into an ocean in the future.
2. The Mediterranean Sea will transform into a mountainous continental **region**.

The movement of tectonic plates causes the shape of the Earth's surface to change **very slowly**. Continuous changes can also be observed due to powerful natural phenomena that affect the shape of the Earth's surface suddenly and violently, occurring **quickly**, such as earthquakes, volcanoes, and meteorites.

Earthquakes

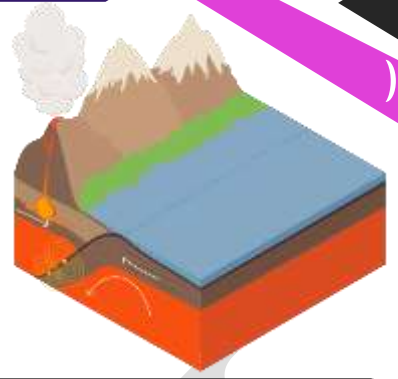
When rocks break, the enormous potential energy stored in the rocks is released and transformed into seismic waves (kinetic energy).



Earthquakes

Rapid, successive natural earthquakes that occur in the crust.

Explaining the occurrence of earthquakes according to the theory of plate tectonics:



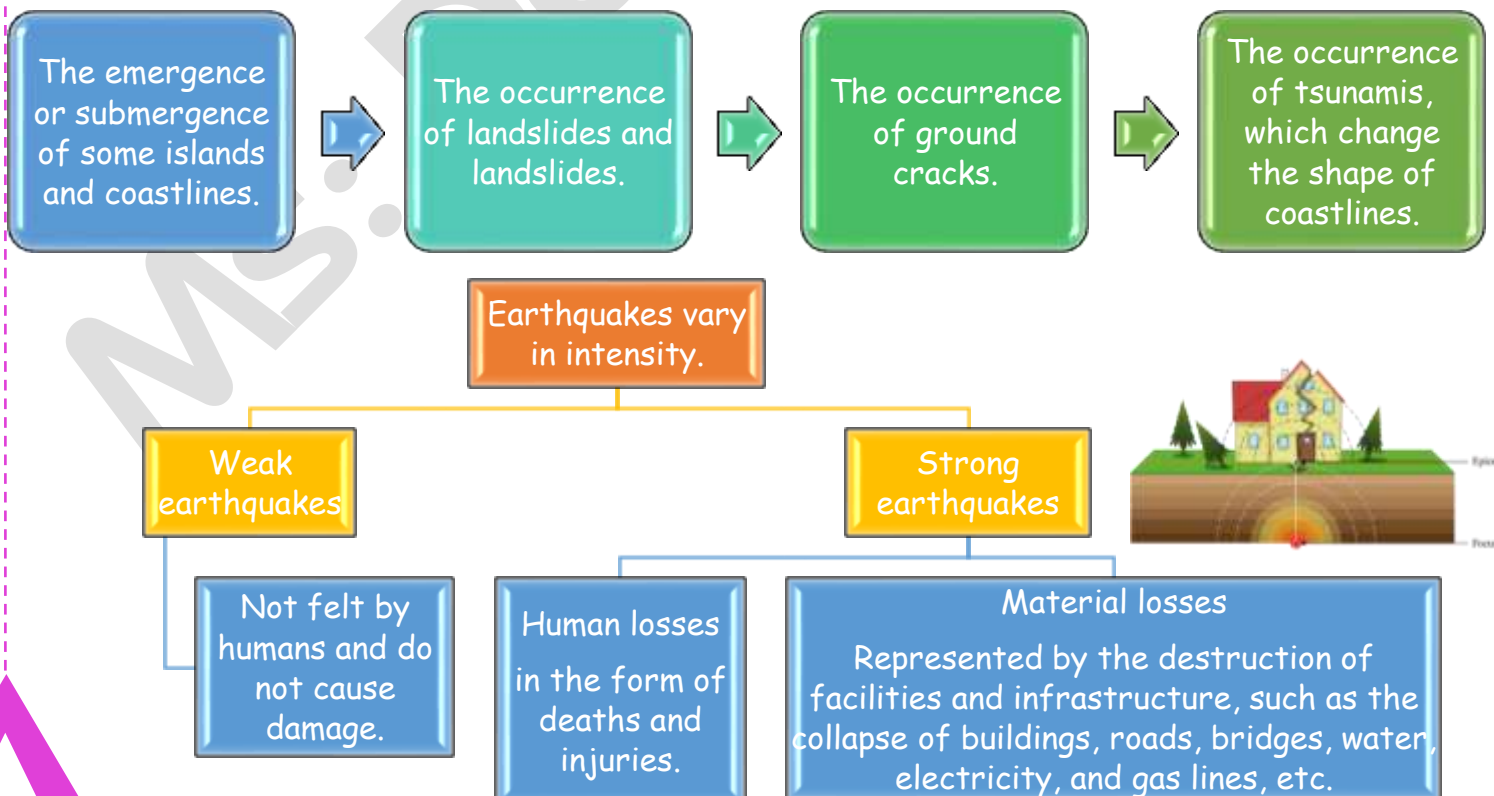
The movement of tectonic plates leads to the storage of a tremendous amount of energy in rocks.

When rocks break, this stored energy at plate boundaries is released into kinetic energy in the form of waves.

What is known as tectonic earthquakes is formed.

There are several types of earthquakes, the most common of which are tectonic earthquakes. Earthquakes occur most frequently at the edges of tectonic plates.

The role of strong earthquakes in changing the Earth's surface:



volcano

An opening in the Earth's crust that allows molten rock and trapped gases to escape to the Earth's surface.

Explaining the occurrence of a volcano according to the theory of plate tectonics



The convergent movement of tectonic plates leads to the melting of rocks, forming magma.

The divergent movement of tectonic plates creates a void (crack) between the plates, into which magma rushes.

Magma rises to the surface through voids, forming volcanoes at plate boundaries.

The role of volcanoes in changing the Earth's surface:

1. Formation of volcanic mountains, such as the **Harrat Rahat Mountains** in Saudi Arabia.
2. Formation of flat plains and plateaus.
3. Changing the course of river courses.
4. Formation of volcanic islands, such as the **Hawaiian Islands**.
5. Covering valleys and rivers (their disappearance).



Volcanic damage

Human losses

Due to inhaling toxic gases and volcanic ash.

Environmental losses

Cities covered in volcanic ash, which could lead to:
The disappearance of cities.
Air and water pollution.
Acid rain.

Note: Earthquakes are similar to volcanoes in that they do not occur in random locations, but rather are distributed in a clear pattern along tectonic plate boundaries.

Tsunamis are high sea waves caused by powerful earthquakes or volcanic eruptions beneath the ocean floor. These waves move at tremendous speeds and cause severe destruction when they reach coastlines.

Meteorites

Rocky masses that penetrate Earth's atmosphere and fall to Earth, some of which cause massive circular craters.

Examples of craters caused by meteorites:

- 1 - Arizona Crater in the United States.
- 2 - Mount El Kamel Crater in the Western Desert, New Valley Governorate, Egypt.

Scientists assume that meteorites caused the extinction of dinosaurs long before the existence of humans.

Technology Application

NASA has developed an advanced radar system known as **DART**.

The **DART** radar's function is to:

- Change the orbit of meteoroids to protect Earth from meteoroid collisions.



Questions

Write the scientific term:

- (1) A supercontinent, hypothesized by Wegener 200 million years ago. (.....)
- (2) The Earth was once a single continent, then gradually separated over time until the continents took on the shape they have today. (.....)
- (3) Layers of molten rock over which tectonic plates move due to convection currents. (.....)
- (4) The lithosphere, consisting of the Earth's crust and the solid part of the upper mantle. (.....)
- (5) The layer of molten rock in the upper mantle. (.....)
- (6) The modern development of the continental drift hypothesis. (.....)
- (7) The plates that make up the Earth's lithosphere. (.....)
- (8) The movement of tectonic plates away from each other. (.....)
- (9) The movement of tectonic plates toward each other, with one sliding beneath the other. (.....)
- (10) The movement of tectonic plates aligned side by side. (.....)

Correct the underlined part:

- (1) The asthenosphere consists of the Earth's crust and solid mantle. (.....)
- (2) Convection currents occur beneath tectonic plates in the outer core. (.....)
- (3) Downward convection currents lead to the transformational movement of tectonic plates. (.....)
- (4) The Andes mountain ranges originated from the convergence of two continental plates. (.....)
- (5) The Andes mountain ranges are higher than the Himalayas. (.....)
- (6) Transform boundaries are where tectonic plates move apart. (.....)
- (7) Convergent movements of tectonic plates are caused by upward convection currents. (.....)
- (8) The divergent movement of tectonic rocks leads to the formation of volcanic islands. (.....)

Put (✓) or (X):

- (1) Wegener proposed the hypothesis of plate tectonics. ()
- (2) The Earth was originally a single, massive continent. ()
- (3) The oceanic crust is less thick and dense than the continental crust. ()
- (4) Downward convection currents cause the divergent movement of tectonic plates. ()
- (5) The divergent movement of tectonic plates leads to the creation of new continental or oceanic crust. ()
- (6) The islands of Japan were formed due to the convergent movement of two oceanic plates. ()
- (7) The peaks of the Himalayas are higher than the peaks of the Andes. ()
- (8) When an oceanic plate diverges from a continental plate, the oceanic plate subducts beneath the continental plate. ()
- (9) A sea may transform into an ocean in the future as a result of the movement of tectonic plates. ()

What is meant by each of the following:

- | | | |
|---------------------------|-----------------------|------------------------|
| (1) Pangaea. | (2) Continental drift | (11) Convergent |
| (3) Lithosphere. | hypothesis. | boundaries. |
| (5) Plate boundaries. | (4) Plate tectonics. | (12) Volcanoes. |
| (7) Convergent motion. | (6) Divergent motion. | (13) Meteorites. |
| (9) Divergent boundaries. | (8) Transformation. | (14) DART radar system |
| | (10) Earthquakes. | |

Give Reason for:

- (1) Tectonic plate movement.

.....

- (2) Divergence of tectonic plates.

.....

- (3) The Red Sea is given this name.

.....

- (4) The sliding of oceanic plates beneath continental plates.

.....

- (5) The convergence of tectonic plates toward each other.

.....

- (6) The possibility of the Red Sea transforming into an ocean.

.....

L 2: Mineral & Soil Composition

Geological processes play **essential roles** in the formation of **minerals**, which in turn form rocks.

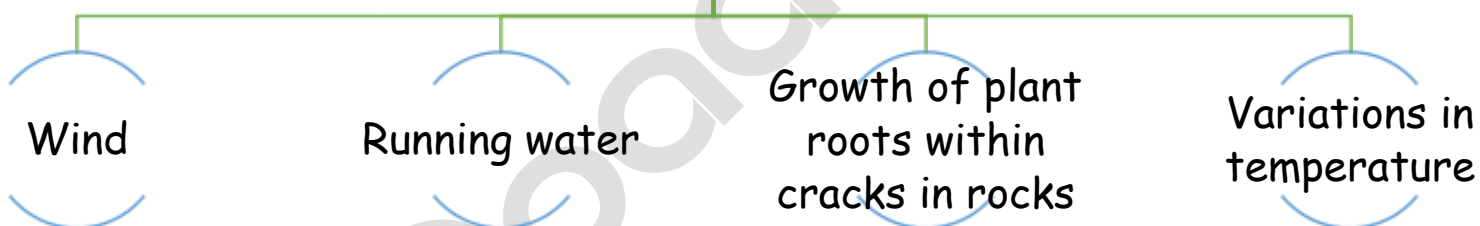
Weathering and erosion of rocks occur, leading to the formation of **soil**.



Weathering: The process of breaking down and disintegrating rocks by mechanical or chemical means.

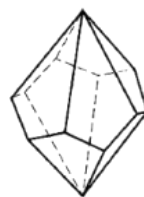
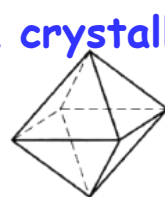
Erosion: The process of transporting rock fragments resulting from weathering away from the areas from which they were transported.

Mechanical
weathering
occurs through



Minerals

Mineral: A naturally occurring, inorganic solid with a crystalline system and a definite chemical composition.



Minerals are found in the form of

Elements	Compounds
sulfur mineral	Hematite is found in the Eastern Desert of Egypt.
	

Why is table salt a mineral, unlike table sugar?

Because table salt (sodium chloride) is an inorganic substance with a crystalline structure and a specific chemical composition, while table sugar is an organic substance derived from living organisms.

Carbohydrates are natural substances with a specific chemical composition. Are carbohydrates considered minerals? Explain.

They are not considered minerals, as they are organic substances derived from living organisms.

Minerals Properties

The true structure of minerals can take the form of fixed (specific) crystals that can be identified using modern equipment. However, there are apparent physical properties that can be recorded among minerals, including:

Color

Luster

Transparency

1) Color

Fixed colors	Variable colors
sulfur	Types of quartz
	 
	Amethyst Clear Quartz

Some minerals are characterized by their multiple colors.

Due to the different types of impurities present in them.

2) Luster

The reflection of light off the surfaces of some minerals, such as galena, gives them a luster (shine) similar to that of metals.

The ancient Egyptians used galena to make eyeliner.



3) Transparency

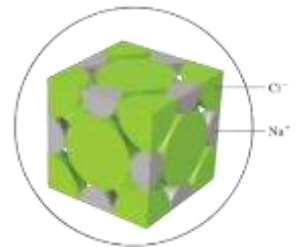
Metals can be distinguished from each other based on their transparency.

Transparency: The ability of a material to transmit light.

Opaque	Semi-transparent	Transparent
Light does not pass through it, so you cannot see things behind it.	Light passes through to a limited extent, so you cannot see things behind it clearly.	Light passes through it so you can see things behind it.
Talc	Mica	Quartz
		

What is the molecular formula for table salt? And what mineral form does it exist in?

The molecular formula for table salt (sodium chloride) is NaCl , and it exists as the mineral halite.



Why is opal described as a mineraloid, even though it has a specific luster and chemical composition, while halite is described as a mineral?

Because opal is amorphous, unlike halite.

Minerals formation in Nature.

* Minerals form in nature from several sources, including:

- Solidification of volcanic magma
- Crystallization of hydrothermal vent solutions



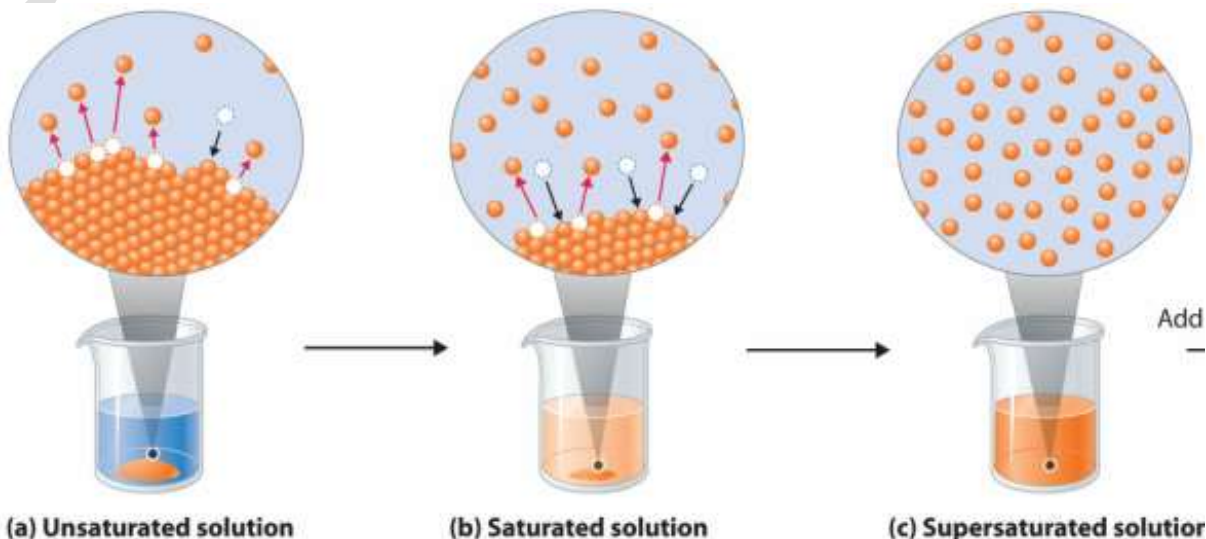
Formation of minerals from the solidification of volcanic magma

Most of the minerals that make up the Earth's crust are formed as a result of the solidification of magma when its temperature drops, transforming it from a liquid to a solid state.

The minerals formed from the solidification of magma vary according to their chemical composition, as follows:

Silica-rich magma		Magnesium- and iron-rich magma	
When it solidifies, it forms minerals		In a relatively high percentage, when it hardens, it becomes a mineral.	
Mica.	Quartz	Olivine.	Pyroxene.
			

Minerals formation from the crystallization of hydrothermal vent solutions



Unsaturated solution

A solution that accepts more solute at the same temperature.



Saturated solution

A solution that does not accept more solute at the same temperature.



Supersaturated solution.

A solution that accepts more solute when the temperature is raised..

Water is the most common and important solvent.

Discover the process of mineral formation from solution crystallization.

Slowly pour a supersaturated solution of hot sodium acetate solution onto a quantity of cold sodium acetate salt.



Excess salt in a supersaturated solution collects around the cold salt in a process known as **crystallization**.

Crystallization: Crystals form from a supersaturated solution when it is cooled.

How minerals are formed from the crystallization of hydrothermal vent solutions.

Hydrothermal vents: Fissures in the ocean floor near active volcanoes, from which hot, mineral-rich water erupts as a result of tectonic plate movement.

Ocean water seeps through porous rocks into cracks beneath the Earth's surface.

This water is heated by the magma temperature to 400 degrees Celsius.

Some of the minerals that make up the surrounding rocks dissolve in this water, forming supersaturated solutions.

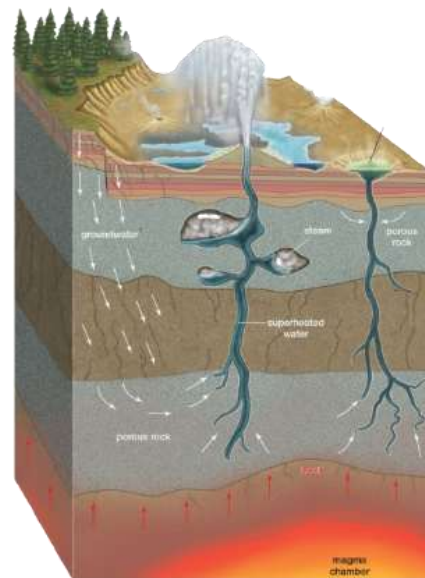
Hot, mineral-laden water rushes back to the Earth's surface through porous rocks.

When super-hot water (400°C) comes into contact with cold ocean water (2°C), minerals such as apatite and calcite crystallize.

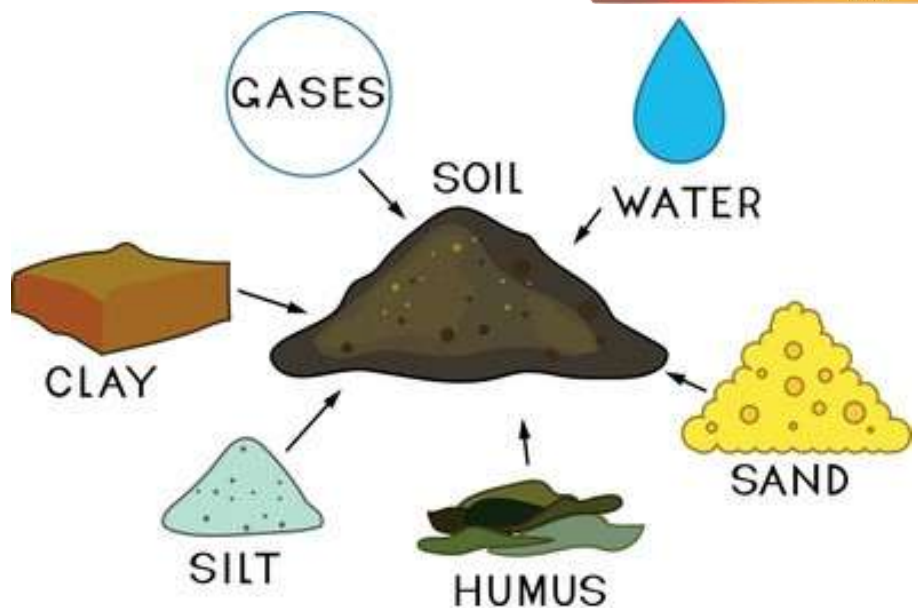
Soil

The surface layer of the Earth's crust resulting from the disintegration of rocks and the decomposition of organic matter.

Humus: Decomposed organic matter.



Soil Component



Soil is classified according to its method of formation into several types, including: **Transported soil** **Sedentary soil**

Transported soil

Soil that was disintegrated in one location and then transported to another.

Most of the Egyptian agricultural soil currently used for agriculture is transported soil. Transported soil includes several types, including riverine soil.

Riverine soil: Soil that was disintegrated in one location and then transported to another by rivers.

Examples of river-transported soils:

The Nile Delta soil was formed by the transport of rock fragments from the Ethiopian Plateau to Egypt via the Nile River over millions of years. Therefore, the transported soil differs from the overlying rock in its current location in terms of chemical composition.

Sedentary soil

It's the Soil formed in its current location.

It includes several types, including residual soil.

Residual Soil: Soil formed as a result of the slow weathering of rocks in the same location.

The slow weathering of rocks (the cause) in the same location leads to the formation of soil known as residual soil (the result). Therefore, the residual soil resembles the original overlying rock in chemical composition.



Examples of local residual soil in Egypt: **Mariout soil, Oasis soil.**
Both formed from the disintegration of sandstone and limestone rocks.

Compare riverine soil and residual soil in terms of the chemical composition of the overlying rock, providing an example of each in Egypt.

- The chemical composition of riverine soil differs from the chemical composition of the overlying rock because it was transported from a location other than where it was formed. An example of this is the Nile Delta soil.
- The chemical composition of residual soil matches the chemical composition of the overlying rock because it was formed by the slow weathering of rocks in the same location. Examples include Mariout soil and oasis soil.



Transported Soil Vs Residual Soil

Limited Non-Renewable Resources

With the beginning of the Industrial Revolution in the late 18th century, the consumption of non-renewable resources increased, especially with the increase in population and the advancement of industry. This threatens their depletion, especially since their formation takes millions of years.

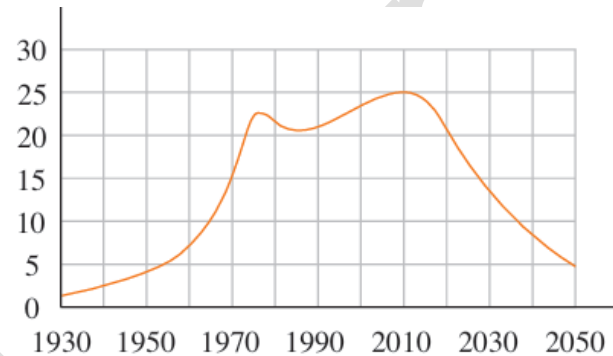
Non-renewable resources include **minerals and fossil fuels**.

Non-renewable resources...

Resources that can be obtained from the Earth's atmosphere other than the biosphere, and that cannot be replaced once consumed.

From studying the graph opposite, which shows oil production rates over 120 years, we can see the following:

1. Oil production increased by 10 billion barrels between 1970 and 2010.
2. The rate of oil production generally decreases over time.
3. The decline in oil production after 2010 led to a rise in the price per barrel on the global market.



In light of the data shown in the graph, it is expected that oil will run out in the year 2070 if its production continues.

From the above, it can be concluded that:

* The need to reduce the rate of depletion of non-renewable resources...Why? **As Limited non-renewable resources.**

The unequal distribution of natural resources leads to their depletion due to:

- Increased human activity in the field of fossil fuel mining.
- The control of mining companies in developed countries over non-renewable resources in developing countries through agreements.

Mining: Extraction of natural resources from the ground.



We must work to sustain non-renewable natural resources and protect them from depletion by:

1. Switching to renewable sources such as solar, wind, and hydropower.
2. Recycling metals instead of new mining.
3. Using technologies that consume less energy, such as electric cars and energy-efficient appliances.
4. Developing industrial alternatives to resources, such as rechargeable batteries.

Questions

Write the scientific term:

- (1) The process of disintegrating and breaking up rocks by mechanical or chemical means. (.....)
- (2) The process of transporting rock fragments resulting from weathering away from the areas from which they were transported. (.....)
- (3) A naturally occurring, inorganic solid with a crystalline structure and a definite chemical composition. (.....)
- (4) The ability of a substance to transmit light. (.....)
- (5) The primary chemical component of the magma that forms mica. (.....)
- (6) Soil carried from one place to another by rivers. (.....)
- (7) Soil that formed in the same place where it currently exists. (.....)
- (8) Soil that formed as a result of the slow weathering of rocks in the same place. (.....)
- (9) Resources that cannot be replaced once they are consumed. (.....)
- (10) Extraction of natural resources from the Earth's interior. (.....)

Correct the underlined part:

- (1) Wind and running water are methods of chemical weathering. (.....)
- (2) Bauxite contains red iron oxide. (.....)
- (3) Table sugar is extracted from halite. (.....)
- (4) Quartz changes color depending on the type of basic elements present in it. (.....)
- (5) Graphite is a lustrous mineral used by the ancient Egyptians to make eyeliner. (.....)
- (6) Mica is an opaque mineral. (.....)
- (7) Hematite crystals consist of positive sodium ions and negative chloride ions. (.....)
- (8) Mica forms from the solidification of magnesium-rich magma. (.....)
- (9) Bound soil is a type of transported soil. (.....)

Put (✓) or (X):

- (1) Rocks undergo mechanical weathering due to temperature differences. ()
- (2) Minerals are composed of organic matter. ()
- (3) Minerals can be distinguished by their transparency and luster. ()
- (4) Quartz is a transparent mineral, which may be found in a pinkish color. ()
- (5) Opal is a semi-mineral, although it has a definite crystal structure. ()
- (6) Mica is formed by the crystallization of hydrothermal vent solutions. ()
- (7) Magma may be rich in silica, magnesium, and iron. ()
- (8) Apatite and halite are minerals formed by crystallization. ()
- (9) The Mariout soil is similar in origin to oasis soil. ()
- (10) River soil is a local soil type. ()

What is meant by each of the following:

- | | | |
|-------------------|------------------------------|------------------------|
| (1) Weathering. | (6) Supersaturated solution. | 10) Humus |
| (2) Erosion. | (7) Crystallization. | (11) Sedentary soil. |
| (3) Mineral. | (8) Hydrothermal vents. | (12) Transported soil. |
| (4) Transparency. | 9) Soil | (13) River soil. |
| (5) Solution. | | (14) Mining. |

Give Reason for:

- (1) Plants play an influential role in the weathering of rocks.
.....
- (2) Sulfur can be distinguished from hematite by color.
.....
- (3) Glucose is not a mineral.
.....
- (4) The purity of quartz can be identified by its color.
.....
- (5) Opal is not a mineral, although it has a specific luster and chemical composition.
.....
- (6) The chemical composition of halite differs from that of hematite.
.....
- (7) The chemical composition of the magma that forms mica differs from that of pyroxene.
.....